Honeywell Enraf

Service Manual
SmartRadar FlexLine

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CHAPTER 1 GENERAL

1.1 Target Group for this Service Manual

This SmartRadar FlexLine Service Manual is meant for service engineers who are assigned to commission a SmartRadar FlexLine.

1.2 Structure of this Manual

Chapter Title	Contents Description
1 - GENERAL	This introductory manual part
2 - SAFETY	Here all safety-related information is housed. All essential and mandatory safety instructions, precautions, and measures are described here. Moreover, the used safety conventions, the labelling information, and compliance information can be found in this chapter.
3 - SYSTEM ARCHITECTURE	This chapter gives an introductory impression of the SmartRadar FlexLine's modular-shaped hardware architecture.
4 - SERVICE TOOLS	In this chapter, both the SmartView and the Engauge service tool are described in more detail.
5 - INSTALLATION	To make sure the relevant module (s) is (are) properly installed, before starting with commissioning, only a reference is made here to the *Installation Guide* for the SmartRadar FlexLine.
6 - COMMISSIONING	This chapter gives all information needed for a proper commissioning of one or more SmartRadar FlexConn modules.

1.3 Related Documents

- SmartRadar FlexLine Safety instructions for installation, commissioning, operation, and maintenance; shipped with the device
- Installation Guide SmartRadar Antennas
- CE Declaration of Conformity *[not available for OneWireless option]*
- EC-Type Examination Certificate *[not available for OneWireless option]*
- IEC-Ex Certificate of Conformity *[not available for OneWireless option]*
- FCC Authorization
- Control drawings for FM and CSA
- OneWireless Wireless Builder User's Guide
- OneWireless Key Server Manager User's Guide

1.4 Trademarks

HART® is a registered trademark of the HART Communication Foundation.

1.5 Contact

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CHAPTER 2 SAFETY

2.1 General

The SmartRadar FlexLine is a radar-based level gauge to be used in inventory measurement systems. It can also be used to interface with other systems and sensors such as pressure, density, or temperature sensors.

For the correct and safe servicing of this product, it is essential that all personnel follow generally accepted safety procedures in addition to the safety precautions specified in this document.

2.2 Safety Conventions

2.2.1 Warnings

Following warning mark is used within this document to urge attention in order ***to prevent personal injuries*** or dangerous situations, further described within this document.

Symbol	Description	Remark
	General warning	Will always be explained by text.

2.2.2 Cautions

Following caution mark is used within this document to urge attention in order ***to prevent damages to the equipment*** further described within this document.

Symbol	Description
	General caution sign

2.3 Safety Instructions

2.3.1 Safety Instructions

See the safety instructions shipped with the device for installation, commissioning, operation, and maintenance.

2.3.2 EC Declaration of Conformity (for EU)

Refer to the EC declaration of conformity shipped with the device.

2.3.3 Control Drawings for FM & CSA

Refer to the control drawings shipped with the device.

2.3.4 Users

The mechanical and electrical installation must be carried out only by trained personnel with knowledge of the requirements for installation of explosion-proof equipment in hazardous areas.

The entire installation procedure must be carried out in accordance with national, local, and company regulations.

The entire electrical installation shall be carried out in accordance with the national requirements for electrical equipment to be installed in hazardous areas.

NOTE: See EN IEC 60079-14 or NEC (NFPA70).

2.3.5 Additional Information

If you require additional information, contact Enraf or its representative.

2.3.6 Environmental Conditions

Observe the environmental conditions for the temperature and the pressure.

2.4 Liability

The information in this installation guide is the copyright property of Enraf B.V., Netherlands. Enraf B.V. disclaims any responsibility for personal injury or damage to equipment caused by:

- Deviation from any of the prescribed procedures,
- Execution of activities that are not prescribed,
- Neglect of the safety regulations for handling tools and use of electricity.

The contents, descriptions and specifications in this Service Manual are subject to change without notice. Enraf B.V. accepts no responsibility for any errors that may appear in this Service Manual.

WARNING! Only certified technicians are authorized to make changes on the SmartRadar configuration. All modifications must be in accordance to the guidelines as set forth by Enraf. Modifications not authorized by Enraf will invalidate the approval certificates.

2.5 Labels

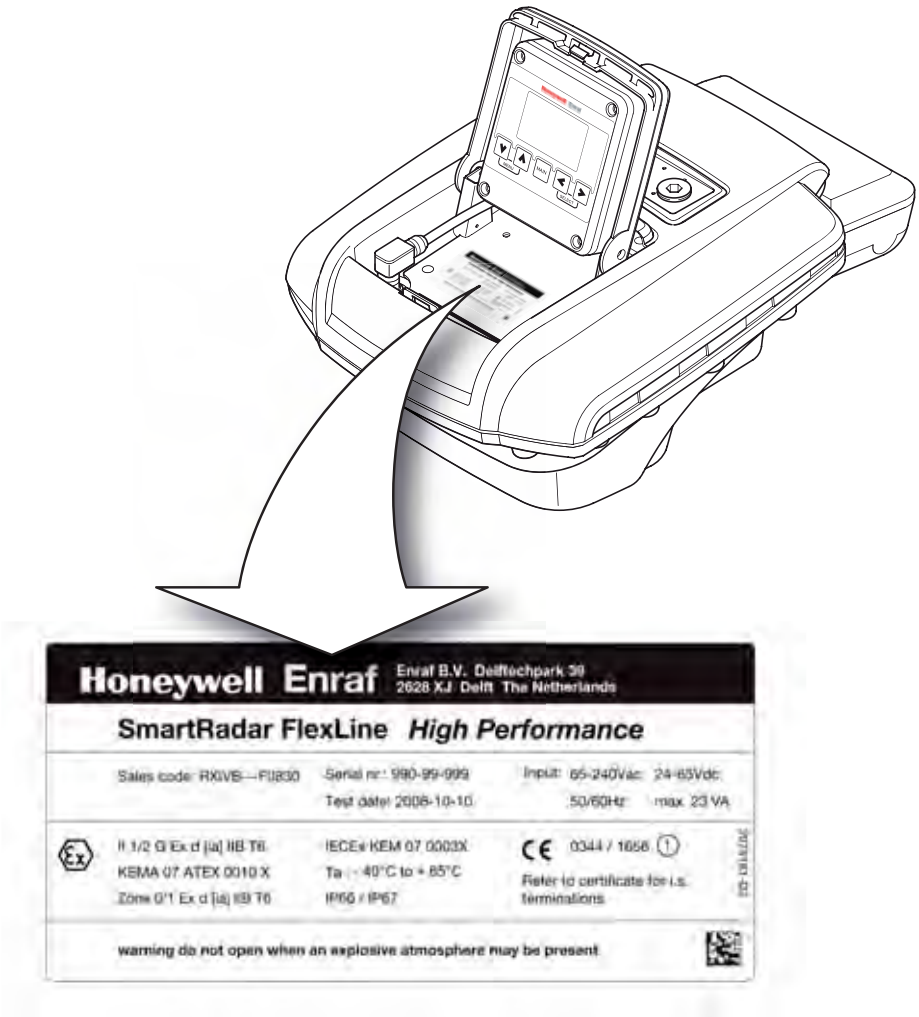

Honeywell Enraf
Enraf B.V. Delftechpark 39
2628 XJ Delft The Netherlands
SmartRadar FlexLine High Performance
Sales code: RXVS---FU230
Serial nr.: 999-99-999
Test date: 2008-10-10
Input: 85-240Vac 24-65Vdc
50/60Hz max. 23 VA
II 1/2 G Ex d [ia] IIB T6
KEMA 07 ATEX 0010 X
Zone 0/1 Ex d [ia] IIB T6
IECEx KEM 07.0003X
Ta : -40°C to + 85°C
IP66 / IP67
0344 / 1658
Refer to certificate for i.s. terminations
warning do not open when an explosive atmosphere may be present

FIGURE 2-1 Identification label with Safety note on the SmartRadar FlexLine

2.6 Personal Safety

WARNING! In hazardous areas it is compulsory to use personal protection and safety gear.
This can be: Safety helmet, fire-resistive overall, safety shoes, safety glasses, working gloves, LEL-meter.

Pay attention to the kind of product in the tank. If there is any danger for your health, wear a gas mask and take all necessary precautions.

WARNING! Take appropriate precautions when chemical or toxic product vapors are present (compressed air, chemical protection suit, detection equipment).

NOTE: The emitted microwave energy is far below the accepted limits for exposure to the human body. The device was tested in conformity with parts of the following standards and/or publications:
- 1999/519/EC COUNCIL RECOMMENDATION of 12 July 1999
- t.b.d.

2.7 Warnings and Cautions

2.7.1 General

2.7.1.1 Opening of the Instrument

When it is required to open the instrument in an explosive hazardous environment, take care of the following.

WARNING! Make sure that all power to the device is switched off before you open the covers of the device. Failure to do so may cause danger to persons or damage the equipment. All covers of the device must be closed before switching the power on again.

WARNING! Treat the flange surface of the cover and the housing with care.
Keep the flange surface free of dirt.
The O-ring must be present and undamaged.

2.7.1.2 Closing of the Instrument

Cover flanged joint must be cleained before closing.

The closing flange bolts of the lid of the SmartRadar FlexLine must be fastened with a torque of 15.5 Nm.

2.7.1.3 Tools

WARNING! Use non-sparking tools and explosion-proof testers. Use suitable explosion-proof tools (e.g. testing devices)!

2.7.1.4 Working Environment

2.7.1.4.1 Hazardous Zone

WARNING! Potential Electrostatic Charging Hazard!

Avoid generation of static electricity.

In case a OneWireless SmartRadar FlexLine is installed, do NOT wipe the surface of the antenna with dry cloth, and do NOT clean its surface with a solvent.

If electrostatically charged, discharge of the antenna surface to a person or a tool could ignite a surrounding hazardous atmosphere.

2.7.1.4.2 Safe Zone

WARNING! Avoid generation of static electricity. Make sure no explosive gas mixtures build up in the working area.

2.7.1.5 Required Skills

WARNING! The technician must have technical skills to be able to safely install the equipment. The technician also must be trained to work in accordance with the national requirements for electrical equipment in hazardous areas.

2.8 Electrical

2.8.1 IEC Safety Standards

- The entire electrical installation must be in accordance with the International Standard EN IEC 60079-14 for electrical equipment in hazardous areas or with NEC (NFPA70) requirements.
- The stopping plugs, cable glands and reducers must be installed in accordance with appropriate IP requirements
- Use explosion proof (Ex-d) compound barrier glands (due >2 litres IIB) in case of use without SmartConn (Ex-e junction box).
- Use increased safe (Ex-e) cable glands in case a SmartConn box is used.
- Improper installation of cable glands, conduits or stopping plugs will invalidate the Ex approval of this device.

2.8.2 Grounding

WARNING! Make sure the housing of the device is properly connected to the ground reference! Make sure that the electrical resistance of the ground connection is below the maximum of prescribed by local requirements!

2.9 Accordance to Regulations

2.9.1 Explosion Safety - Without SmartConn

Type of protection:

ATEX / IEC Ex / CSA / FM

Certificate numbers:

ATEX / IEC Ex *[pending for OneWireless option]*

- SmartRadar FlexLine:
  KEMA 07ATEX0010X and IECEX KEM 07.0003 X.

- SmartView: KEMA 07ATEX0011X and IECEX KEM 07.0004 X.
- SmartConn: KEMA 07ATEX0093 and IECEX KEM 07.0031.
- Without SmartView: Ex d [ia] T6 Ta: -40 °C - +65 °C.
- With SmartView: Ex d [ia] ia T4 Ta: -25 °C - +65 °C.

FM *[including OneWireless option]*

- Without SmartView:
  Class I DIV I group C,D T6 NEMA 4X Ta: -40 °C - +65 °C.
- With SmartView:
  Class I DIV I group C,D T4 NEMA 4X Ta: -25 °C - +65 °C.

CSA *[pending for OneWireless option]*

- Without SmartView:
  Class I DIV I group C,D T6 NEMA 4X Ta: -40 °C - +65 °C.
- With SmartView:
  Class I DIV I group C,D T4 NEMA 4X Ta: -25 °C - +65 °C.

2.9.2 Explosion Safety - With SmartConn

Type of protection:

ATEX / IEC Ex / CSA *[pending for OneWireless option]*

- Without SmartView: Ex de [ia] T6 Ta: -40 °C - +65 °C.
- With SmartView: Ex de [ia] ia T4 Ta: -25 °C - +65 °C.

2.9.3 Compliance to FCC, R&TTE, IC

This device complies with EN 302372 of the R&TTE Directive, Part 15 of the FCC Rules, and RSS-Gen of IC. The device does not cause harmful interference and accepts any interference received.

WARNING! Changes or modifications made to this equipment not approved by Enraf B.V. invalidate the R&TTE/ FCC/IC authorization to operate this equipment.

CAUTION! This equipment has been tested. It complies with a Field disturbance sensor device, pursuant to Part 15 of the FCC Rules and FCC-Gen for IC. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This device generates, uses and radiates radio frequency energy. If this device is not installed and used in accordance with the instructions, it can cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

NOTE: This device is certified to measure liquid levels in metal, concrete or similar materials, enclosed tanks.

NOTE: The radiated output power of the device is far below the exposure limits. Nevertheless, use the device in such a manner that the potential for human contact during normal operation is minimal.

2.9.4 EN302372-1 ANNEX B

The following installation requirements shall be fulfilled:

1. SmartRadar FlexLine instruments are required to be installed at a permanent fixed position at a closed (not open) metallic tank or reinforced concrete tank, or similar enclosure structure made of comparable attenuating material.
2. Flanges and attachments of the radar equipment shall provide the necessary microwave sealing by design.
3. Sight glasses shall be coated with a microwave proof coating when necessary (i.e. electrically conductive coating).
4. Manholes or connection flanges at the tank shall be closed to ensure a low-level leakage of the signal into the air outside the tank.
5. Whenever possible, mounting of the radar equipment shall be on top of the tank structure with the orientation of the radar antenna to pointing in a downward direction.

WARNING! Do not rub the radio antenna to prevent sparks.

6. Installation and maintenance of the radar equipment shall be performed by professionally trained individuals only.

2.9.5 Low-Voltage Directive

The device is suitable for:

- Pollution degree 2
- Overvoltage category II
- Class I equipment

CHAPTER 3 SYSTEM ARCHITECTURE

3.1 SmartRadar FlexLine Architecture

The SmartRadar FlexLine system is built up from interchangeable hardware modules. These modules consist of uniform printed circuit boards (PCBs), each of them representing a different, unique functionality. Together with the software implemented on these hardware parts, each PCB makes up a so-called FlexConn module. These modules communicate with each other via the serial CAN-bus on the DIN rail backplane - on which they are mounted - or wireless by using the OneWireless Network option. See FIGURE 3-1.

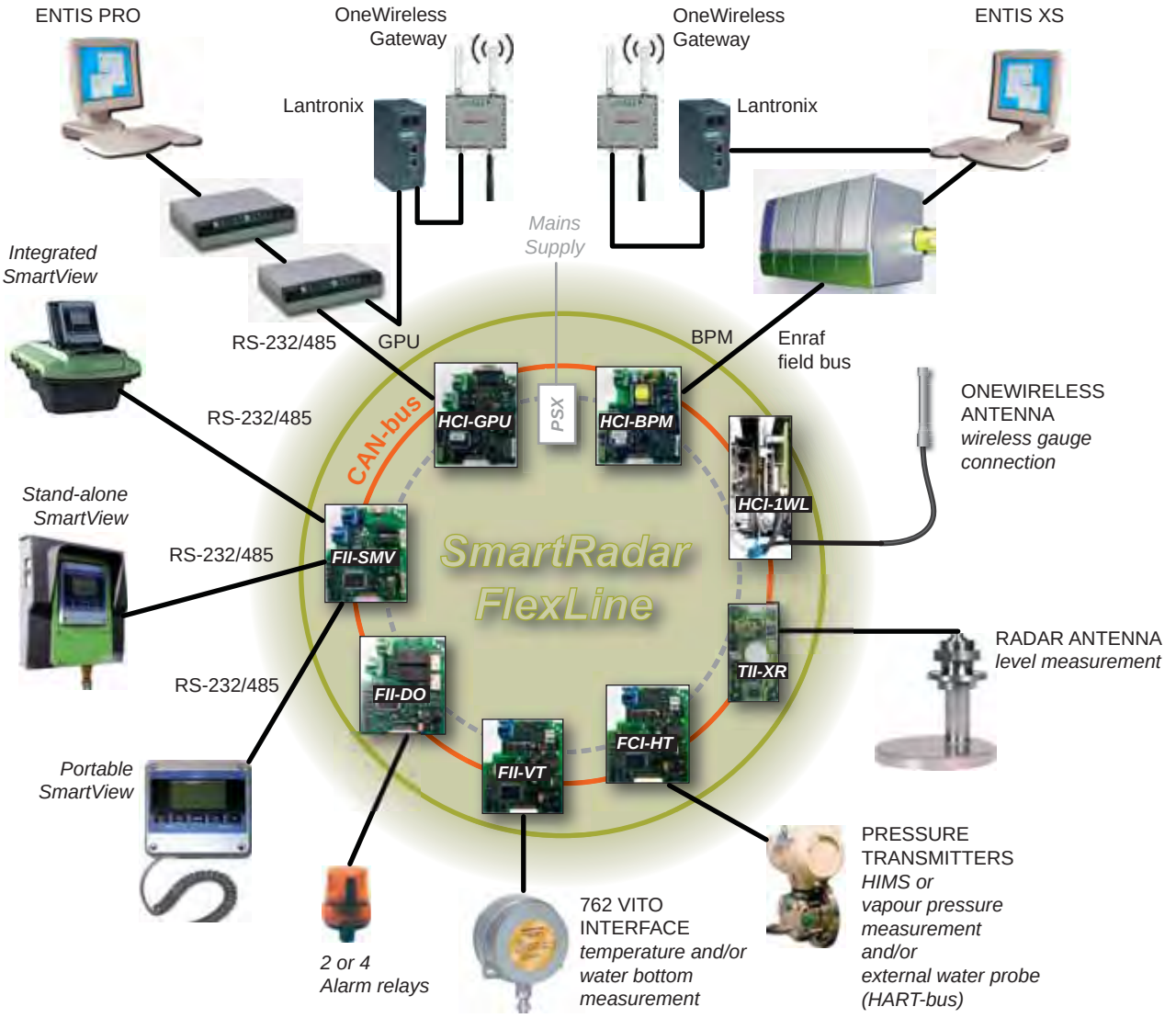


FIGURE 3-1 SmartRadar FlexLine system architecture overview

ESF07-0026

3.2 FlexConn Modules

One of the main characteristics of the SmartRadar FlexLine architecture is its placement flexibility of the FlexConn modules. If desired, any types of modules can be added at any locations. Even placement of 2 identical modules is possible within the SmartRadar FlexLine system.

Each FlexConn module has one or more functions. In general, this can be a *sensor* function, a *communication* function, or a *digital-interface* function.

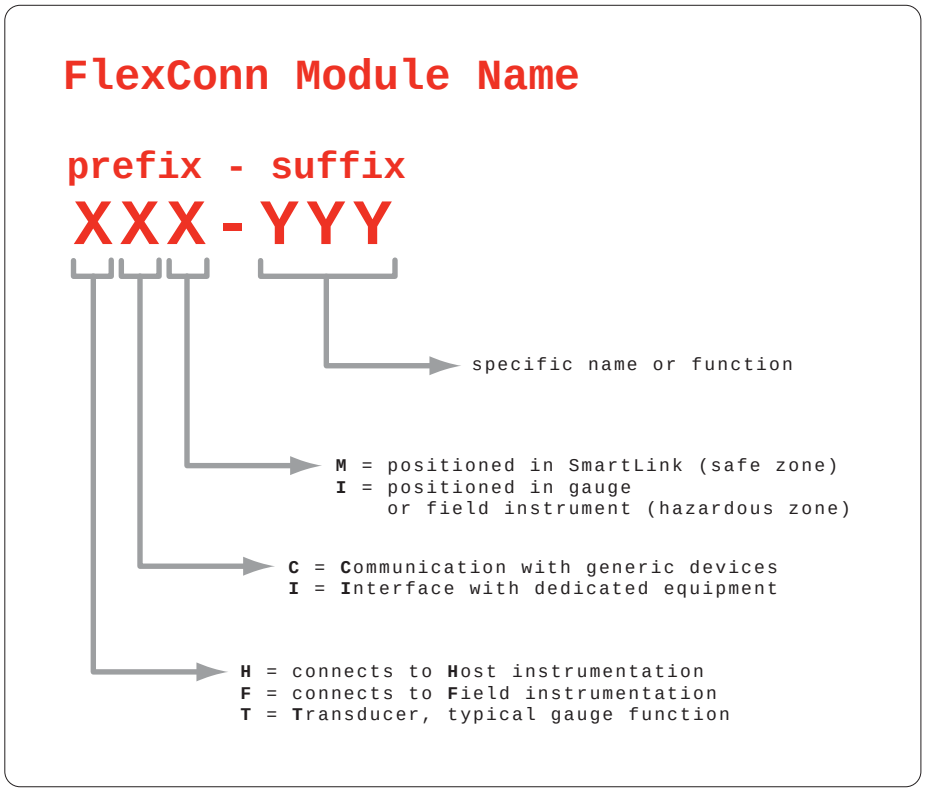
A *sensor* function measures or calculates a process value, or it obtains a process value from a connected external instrument.

A *communication* function takes care of the communication with a communication interface unit or with a DCS, SCADA, tank inventory, or another terminal automation system.

A *digital-interface* function controls digital output or reads digital input from instruments around the storage tank.

NOTE: Some FlexConn PCBs are also used within the so-called SmartLink system.

Each FlexConn module has a unique name, which is built up according to the following outline:


FlexConn Module Name
prefix - suffix
XXX-YYY
specific name or function
M = positioned in SmartLink (safe zone)
I = positioned in gauge
or field instrument (hazardous zone)
C = Communication with generic devices
I = Interface with dedicated equipment
H = connects to Host instrumentation
F = connects to Field instrumentation
T = Transducer, typical gauge function

Each FlexConn PCB consists of a *generic* and a *specific* electronics part. The generic part can be found on any FlexConn modules. The specific electronics part represents an application-specific function. See FIGURE 3-2

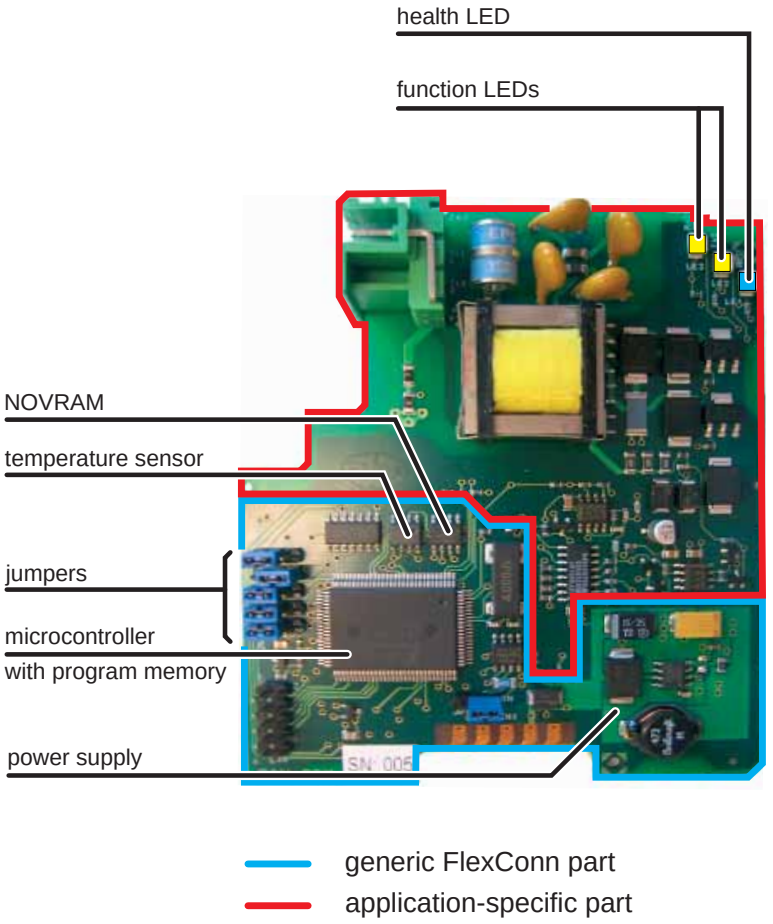


FIGURE 3-2 A typical FlexConn PCB layout

On the *generic* electronics part, the following parts can be found:

- **The program memory**

This memory contains the module-specific software.

- **The microprocessor / controller**

The microprocessor executes the module-specific software stored in the program memory.

- **The non-volatile memory**

Here the commissioning parameters and the diagnostics data are stored when the power is switched off.

■ **Jumpers**:

With the jumpers, specific hardware settings can be made:

Jumper Number	Function
1	all warning and monitoring-related commissioning entities[a] are protected and cannot be changed
2	the password is protected from being read
3	all commissioning entities are protected and cannot be changed
4	board-specific jumper
5	board-specific jumper

a) For an explanation of the *entities* concept, see 3.3.

■ **Health LED**

The Health LED (= LE1, the blue one) indicates the general health status of the FlexConn module:

Health Status	Flashing Pattern
Good	
Uncertain	
Bad	

■ **2 function LEDs**

These LEDS indicate module-specific activities, such as for instance data being transmitted or received.

■ 3 voltage monitors

The output of these monitors, being voltage levels from 3 different FlexConn PCB locations, are used for diagnostics purposes.

See FIGURE 3-3.

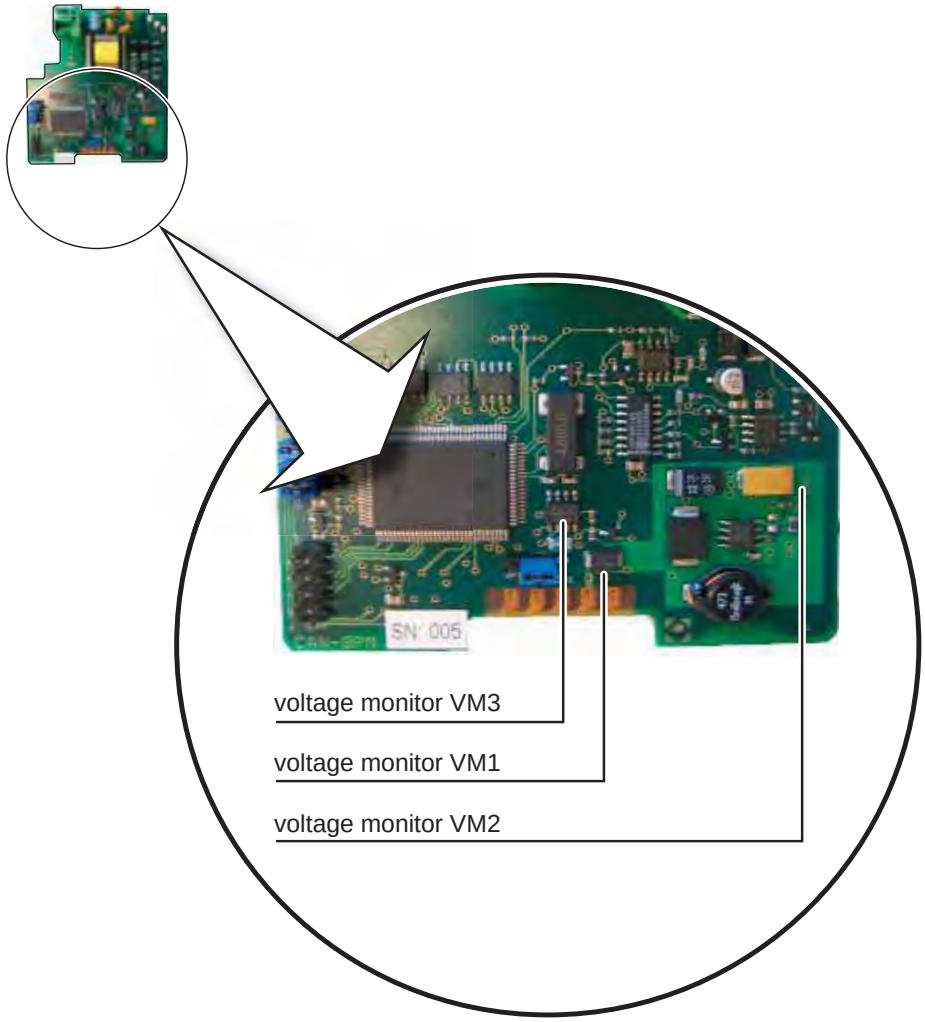


FIGURE 3-3 Locations of the 3 voltage monitors

ESF07-0023

■ 1 temperature sensor

For the operational PCB, this sensor acts as an input for environmental-temperature diagnostics. The PCB's environmental temperature is taken as a measure for the temperature inside the SmartRadar FlexLine.

3.3 Entities

Information exchange between the various FlexConn modules takes place by means of the so-called *entities*.

An *entity* represents a unique information association within the FlexConn architecture. This information may consist of measuring data, status data, commissioning parameters, diagnostics data, or commands.

In addition to information exchange between FlexConn modules, entities are used for data presentation on the SmartView display, and for the communication between the Engauge service tool and the SmartRadar FlexLine.

The entities are represented by a textual description, for example, “Reset”, “Tank bottom”, “Health”, or “Baudrate”.

The entities’ structure is related to:

- general status information;
- the generic FlexConn part;
- the function-specific FlexConn part.

3.3.1 Status Entities

The “Health” and “Commissioned” entities give information about the general FlexConn module status and the functions implemented on this module.

3.3.1.1 Health Entity

The “Health” entity reflects the condition of the entire module, each single module function, and the calculated or measured value of a sensor function.

The “Health” entity structure is defined by following items:

1. status
2. status category
3. status code

The *status* field gives high-level information:

- good
- uncertain
- bad

Residing one level below, the *status category* informs about the general reason *why* the status is good, uncertain, or bad.

Status	Status Category
Good	actual
	manual
	last valid
	stored
Uncertain	instrument
	environment
Bad	general hardware fail
	general firmware fail
	general commissioning fail
	general calibration fail
	general operational fail
	over range (data available!)
	under range (data available!)
	no data available
	un-initialized
	killed

Finally the *status code* informs about the *specific reason* why the status is good, uncertain, or bad. This information is presented as an information number coupled with a textual description of this specific situation. See table below.

Good								Uncertain						Bad							
actual		manual		last valid		stored		instrument			environment			un-init	killed	no data	under range	over range	hw fail	sw fail	cal fail
001	056	077	104	632	328	207	782	065	478	199	389	011	072	.....							

- Each ***board*** implements “health” as generic information based on the function (s) health(s).
- Each ***function*** implements “health” as generic information.
- Each ***sensor*** and ***digital I/O*** function implements an entity called “Primary Value”, which in addition to the actual measured value also contains a “health” status.

3.3.1.2 Commissioned Entity

The “Commissioned” entity informs the end user if the most important commissioning entities of the concerned FlexConn module and its implemented functions are set correctly.

- True = the most important entities are set correctly
- False = the most important entities are ***not*** set correctly

3.3.2 Generic Entity

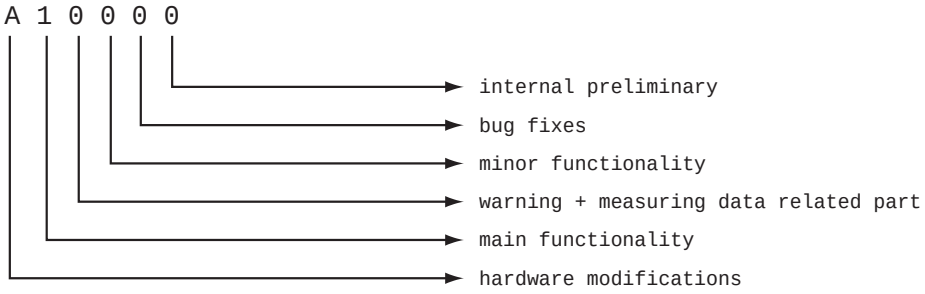
The following command entities are implemented as generic functions:

- “Reset device”
- “Reset board”

The following information is available through the entities:

- “Board name” = FlexConn module name
- “Board hardware version” = Hardware version of the FlexConn PCB
- “Firmware version” = Version of the software running on the FlexConn module

De firmware (software) version data is built up according to the format below:



The last digit will not been shown in the official or formal releases.

3.3.3 Function-specific Entities

For the function-specific entities, see *Chapter 6 - Commissioning*.

3.4 SmartView Display

3.4.1 General

By means of the SmartView most of the FlexConn module settings can be controlled.

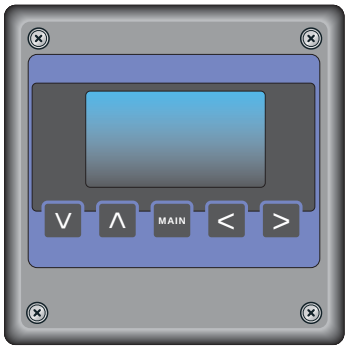


FIGURE 3-4 An impression of the SmartView ESF07-0024

For each *sensor* and *digital I/O* function implemented on a FlexConn module, a Primary Value screen becomes available on the *SmartView* display.

In the left bottom quarter of the display, the Primary Value's "Health" status is shown:

Status	Display Text
Good	
Uncertain	uncertain
Bad	bad

Below the Status field, the Status category is displayed:

Status Category	Display Text
actual	
manual	manual
last valid	last valid
stored	stored
instrument	instrument
environment	environment
general hardware fail	hardware
general firmware fail	software
general commissioning fail	commission
general calibration fail	calibration
general operational fail	operational

Status Category	Display Text
over range	over range
under range	under range
no data available	no data
un-initialized	no init
killed	killed

3.4.2 Status Entities on SmartView

Choosing sub-menu “commissioning” from the main menu, a survey results of all FlexConn modules present in the SmartRadar FlexLine system.

Each module is followed by an indication for the “**H**ealth” and the “**C**ommissioned” status respectively. In case of an unreliable or fault situation, the “**I**nformation” column shows an information code in addition. This information code reveals the specific reason about the current status.

This diagnostics goes for each individual FlexConn module. See example below.

```
            H C I
FII-DO      G N
```

- The “Health” indication can be:

“G” = Good

“U” = Uncertain

“B” = Bad

- The “Commissioned” indication can be:

“Y” = the most important entities are set correctly

“N” = the most important entities are ***not*** set correctly

Starting from the “commissioned” menu and choosing the specific FlexConn module, the above diagnostics is repeated for each module *function*. See example below.

```
FII-DO:>
board       H C I

Relay 1     G N
Relay 2     G Y
Relay 3     U Y nnn
Relay 4     B Y
```

3.4.3 Generic Entities on SmartView

From the functions survey screen of the concerning FlexConn module, the generic entity commands or the commissioning entity can be selected via the “board” entry.

```
FII-DO:>
board       H C I

Relay 1     G N
Relay 2     G Y
Relay 3     U Y nnn
Relay 4     B Y
```

3.4.4 Specific Entities on SmartView

Selecting a specific function, for instance, “Relay 2”, gives access to the specific entities for this function.

The specific entities are described in *Chapter 6 - Commissioning*.

3.5 Engauge Service Tool

The Engauge service tool is a PC application with which all FlexConn module settings can be done as well.

By means of the Engauge's explorer, each FlexConn module of the concerned SmartRadar FlexLine system can individually be selected by double-clicking on the module's icon. The so-called "board descriptor" is loaded then resulting in a screen with "tab" pages. By selecting these tab pages, all settings of the specific module are accessible.

See example below.

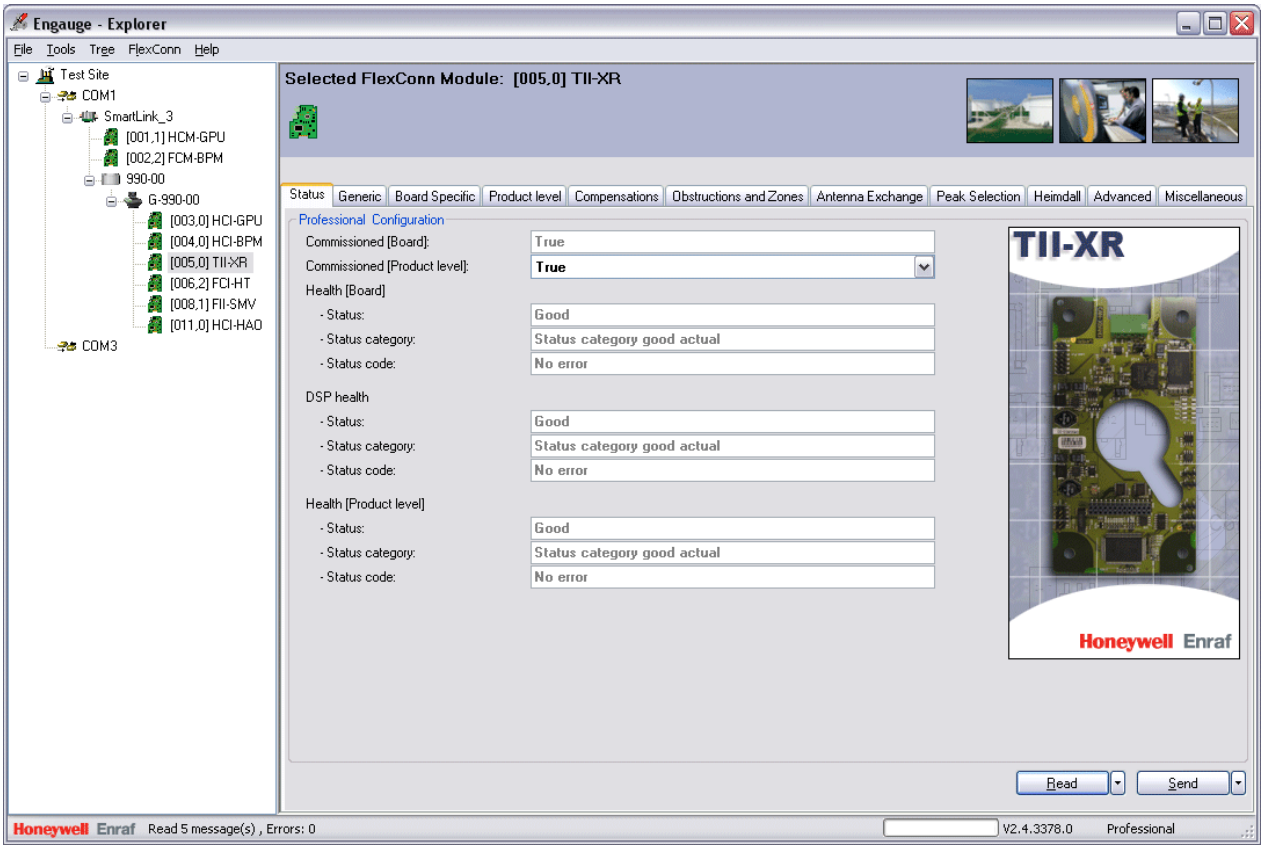


FIGURE 3-5 Example of an Engauge screen

ESF09-0001

3.5.1 Status Entities in Engauge

Each board descriptor user interface starts with the tab page “Status”. On this tab page the “Health” and “Commissioning” entities for the whole module and the individual functions are placed.

3.5.2 Generic Entities in Engauge

The “Status” tab page is always followed by the “Generic” tab page, on which the general commands and diagnostics entities are placed.

3.5.3 Board-specific Entities in Engauge

The “Generic” tab page is always followed by the “Board specific” tab page, on which the board-specific entities are placed. These entities are specific for each individual FlexConn module type. The board-specific entities are further described in *Chapter 6 - Commissioning*.

3.5.4 Specific Entities on Engauge

After the board-specific tab page, for each implemented function on the concerned FlexConn module a specific tab page follows.

For example, for the FII-DO module, the below listed specific tab pages will be present:

- Relay 1
- Relay 2
- Relay 3
- Relay 4

In case of complex functions, extra tab pages may exist, containing those specific functions involved.

The specific entities are described in *Chapter 6 - Commissioning*.

3.5.5 Function-generic Entities on Engauge

The function category “generic entities” are placed at the bottom of each function tab page in Engauge.

For each category (sensor, digital I/O, communication, display), the basic Engauge version will have only one entity:

“Function identification”.

With this entity, the user can change the function name, which will then become available on the SmartView Primary Value screen and in Engauge as well.

CHAPTER 4 SERVICE TOOLS

4.1 SmartView

4.1.1 General

The *SmartView* is the basic tool with which the user can communicate with the SmartRadar FlexLine modules.

As normally open keyboard contacts may be dangerous in an explosion-hazardous environment, the *SmartView* is built up as a totally shielded explosion-safe tool.

4.1.2 SmartView Versions

The *SmartView* can be delivered in 3 versions:

- *SmartView* fixed on the instrument
- *SmartView* as a tank-side indicator (stand-alone)
- A portable *SmartView*

fixed on the instrument | as a tank-side indicator | as a portable tool

FIGURE 4-1 The 3 different SmartView options ESF07-0027

4.1.3 Connections

Within a hazardous environment, connecting or disconnecting electrical equipment is dangerous, because of sparking risks.

The **portable** *SmartView* however is designed such that it **may be connected/disconnected within a hazardous zone**.

The **fixed** version *SmartViews* (integrated within the instrument or tank-side mounted) have pre-installed fixed connections.

4.1.4 SmartView Controls

The SmartView has 5 push buttons and an LCD-screen with a backlight that can be switched on/off as desired. By using a menu, most SmartRadar FlexLine control operations can be done.

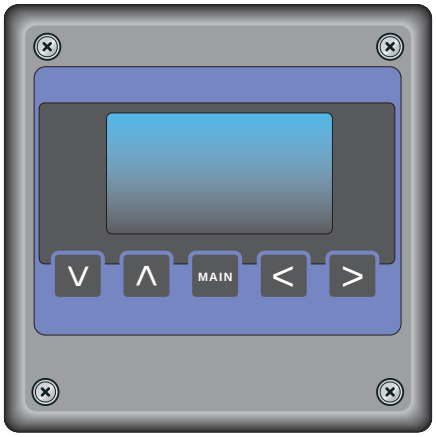


FIGURE 4-2 The SmartView controls ESF07-0024

The buttons have the following functions:

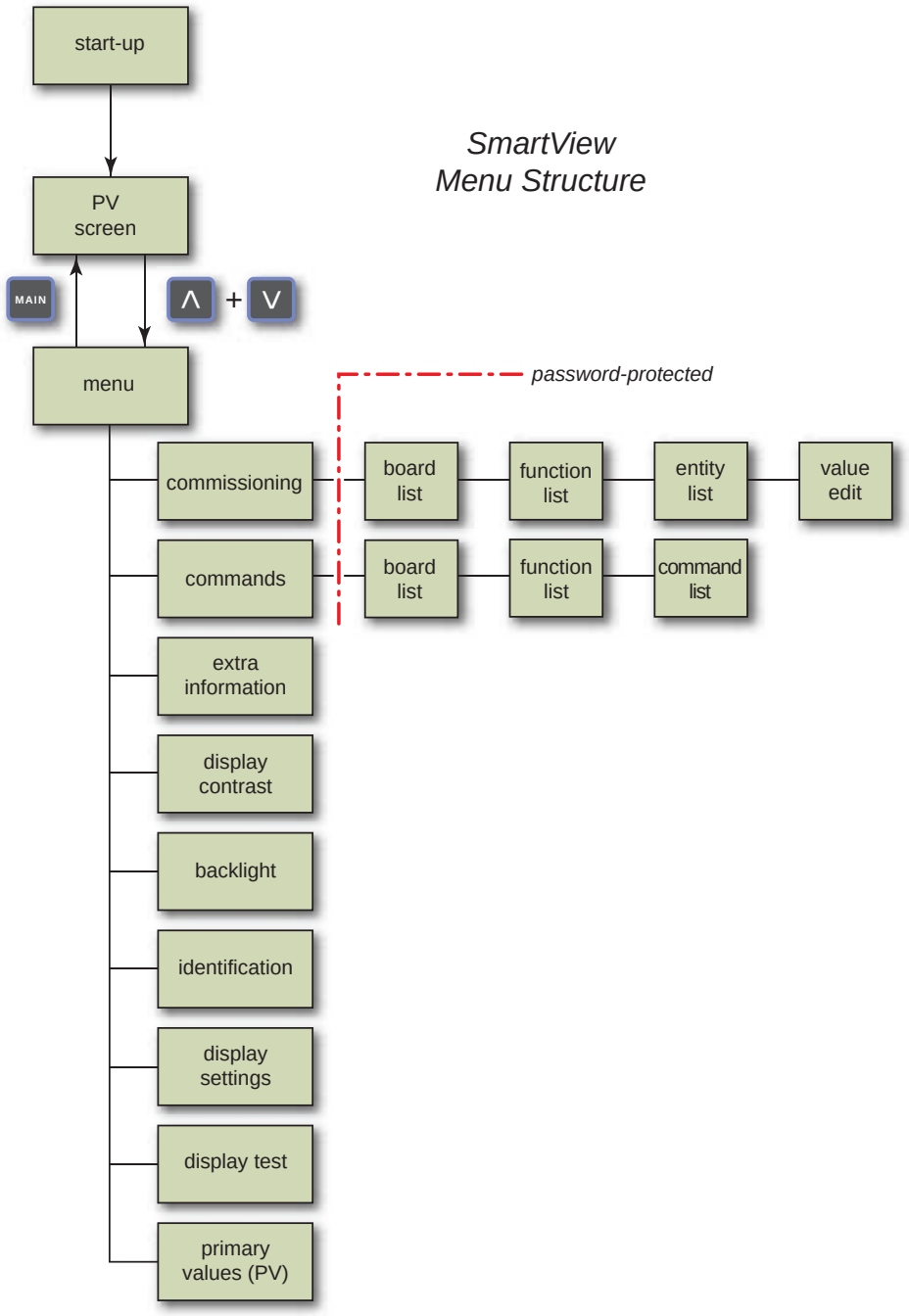
Button	Function *within menu ...*	
>	PV	Go to next PV screen
	Commissioning	Move cursor 1 position to the right
	Display contrast	Increase contrast
	Backlight	Toggle between ON and OFF
	Display settings	Toggle between ON and OFF
<	PV	Go to previous PV screen
	Commissioning	Leave current menu screen, and go to higher-level menu. *Important: Leaving an edit screen this way will undo all editing!*
	Commands	Leave current menu screen, and go to higher-level menu.
	Display contrast	Decrease contrast
	Backlight	Toggle between ON and OFF
	Display settings	Toggle between ON and OFF
< + >	Commissioning	Confirm selected choice
	Commands	Confirm selected choice

Button	Function *within menu ...*	
	Commissioning	Within the *menu* screens, move cursor 1 line up Within the *edit* screens, scroll characters as long as the button is pressed
	Commands	Move cursor 1 line up
	Display settings	Toggle between *Main screen* and *Standby* mode
	Identification	Go to next identification screen
	Commissioning	Within the *menu* screens, move cursor 1 line down Within the *edit* screens, scroll down 1 character
	Commands	Move cursor 1 line down
	Display settings	Toggle between *Main screen* and *Standby* mode
	Identification	Go to next identification screen
	Show menu	
	Go to PV screen	
	Decrease contrast	
	Increase contrast	
	Standby mode - Pressing any buttons will activate SmartView again	

4.1.5 SmartView Menu Structure

4.1.5.1 SmartView Screens

Depending on the state of the menu process and the pressed button(s), following screens can be displayed:



ESF07-0043

4.1.5.1.1 *Start-up Screen*

The *SmartView* starts up showing:

1. Black test
2. Blank test
3. Enraf logo + software version + tank ID
4. PV screen

4.1.5.1.2 *Menu Screen*

By using the [menu] screen of the *SmartView* (see FIGURE 4-3) you can *view and/or modify settings*, or you can *send a specific command* to a sensor or a digital I/O board.

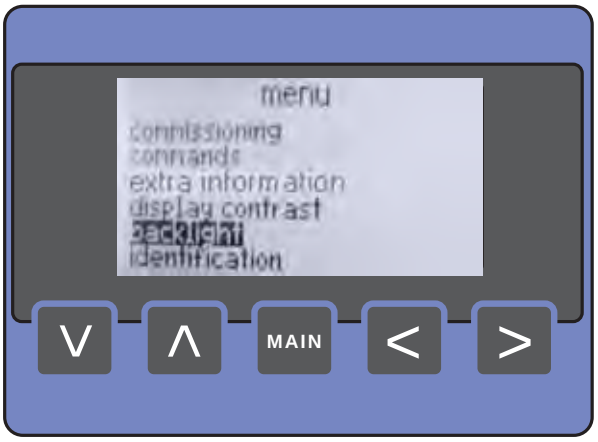


FIGURE 4-3 The menu screen ESF07-0030

Menu Item	Description
[menu]	Screen title.
[commissioning]	Within this menu, configuration parameters can be set
[commands]	Allows you to send a command to a sensor or digital I/O board
[display contrast]	Allows you to adjust the display contrast
[backlight]	Allows you to switch ON or OFF the backlight
[identification]	Shows information about: • Tank name • Tank address • Customer ID • SmartView software version • SmartView address • FlexConn module name, board ID, board instance, and software version

Menu Item	Description
[display settings]	Allows you to switch ON/OFF buttons time-out: • Main screen: If no button is pressed within 15 minutes, *SmartView* switches to PV screen • Standby mode: If no button is pressed within 15 minutes, *SmartView* switches to standby mode
[display test]	Performs blank/black test
[extra information]	The [extra information] screen shows information about a specific function. See also 4.1.5.1.8.

TABLE 4-1 The menu items

4.1.5.1.3 Backlight Screen

The [backlight] screen (see FIGURE 4-4) allows you to *enable/disable the backlight*. The *SmartView* will only turn the backlight ON if following conditions are met:

- [backlight] is enabled by the host
- [backlight] is enabled by the user

When the left or right button is pressed, the backlight setting immediately changes. The backlight setting is stored in non-volatile memory.

ESF07-0031

FIGURE 4-4 The backlight screen

4.1.5.1.4 *Display Contrast Screen*

The [display contrast] screen (see FIGURE 4-5) displays a horizontal scroll bar. By moving the scroll bar, you can *adjust the contrast*. Moving to the right immediately increases contrast, moving to the left decreases contrast.

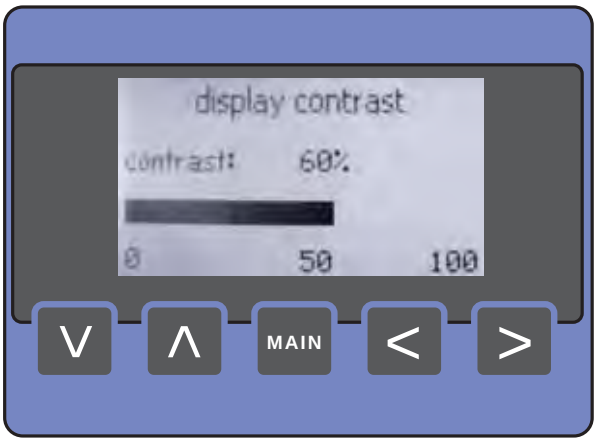


FIGURE 4-5 The display contrast screen ESF07-0032

4.1.5.1.5 *Display Settings Screen*

The [display settings] screen allows you to *set the buttons time-outs*. The screen displays the following items:

Feature	Possible States	Default
Buttons time-out to main screen	ON/OFF	ON
Buttons time-out to standby mode	ON/OFF	ON

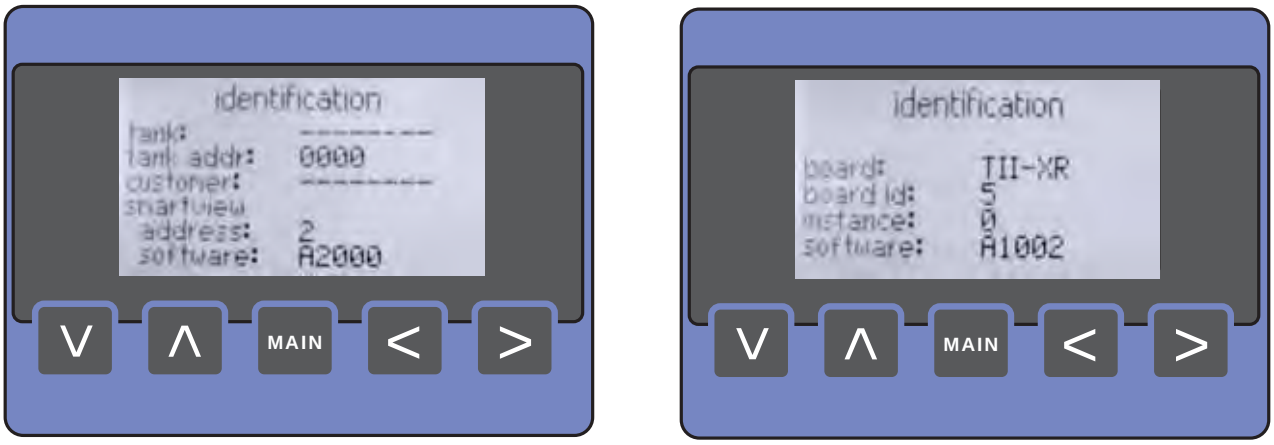
4.1.5.1.6 *Display Test Screen*

When the [display test] screen is selected, *SmartView* performs a *black/blank test*. SmartView begins drawing a rectangle of 64 x 128 pixels, filled with black pixels for a period of 2s. After that, the screen is cleared using a rectangle filled with white pixels for a period of 2s.

4.1.5.1.7 Identification Screen

The [identification] screen (see examples in FIGURE 4-6) allows you to *scroll through the available FlexConn modules*, using the up and down buttons, to obtain information about:

- SmartView (see left screen)
  - the tank name
  - the tank address
  - software version
  - SmartView address
  - customer ID
- FlexConn modules (see right screen)
  - board name
  - board ID
  - instance
  - software version



ESF07-0033 + 0029

FIGURE 4-6 Identification screen examples

4.1.5.1.8 *Extra Information Screen*

The [extra information] mode can be configured to show either the [level & temperature] screen or the [extra information] screen (see FIGURE 4-7). The [extra information] screen *shows information* about a specific function. The specific functions are described in chapter 6. The [level & temperature] screen (see FIGURE 4-7) *shows information* about the measured product level and temperature. In this menu mode, it is *not* possible to change any settings.

NOTE: In case of an error situation, the level fields are filled with "#" and the temperature fields with "9".

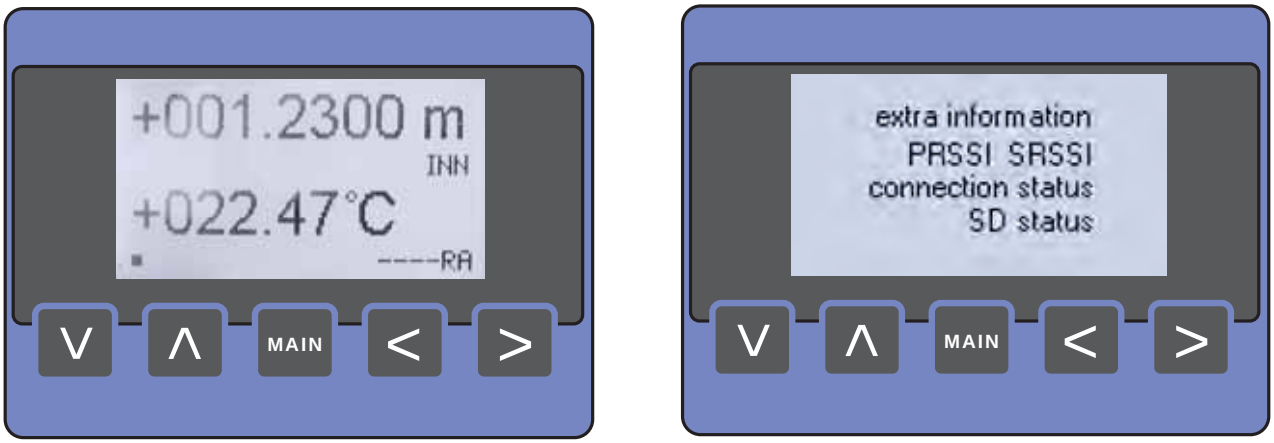


FIGURE 4-7 The level & temperature screen (left) and the extra information screen (right) ESF07-0039/0012

4.1.5.1.9 *Primary Value Screen*

The [Primary Value] screen (PV-screen), shown in FIGURE 4-8, depicts information about data measured by a sensor, or information about the status of a digital I/O. See table TABLE 4-2.

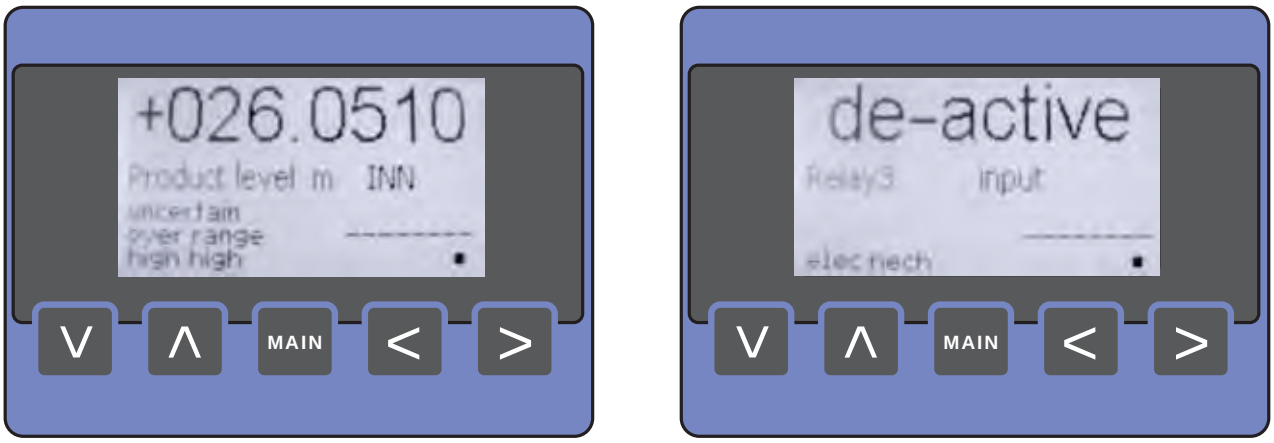


FIGURE 4-8 PV-screen examples (left: level status, right: digital I/O status) ESF07-0028 + 0044

Data Field	Max. Size [characters]	Description
Primary Value	9	The measured value, e.g. +025.1277
PV identification	13	Quantity name, e.g. • Product level • Product temperature • P1 pressure
PV units	5	Quantity unit, e.g. • m • kg/m^3 • kPa
PV type	3	Type can be: • INN (innage) • ULL (ullage) • REL (relative) • ABS (absolute)
PV health	9	Status of the Primary Value: • UNCERTAIN • BAD
PV representation	15	Representation of the PV: • Manual • Last valid • Stored • Instrument • Environment • Hardware • Software • Commission • Calibration • Operational • No data • No init. • Killed • Over range • Under range
PV alarms	9	Alarm type that occurred: • High High • High • Low • Low Low
Tank identification	8	Tank name, e.g. CRUDE 07
Alive indicator	1	Blinking cursor (bottom right) indicates PV being updated

TABLE 4-2 Primary Value (PV) items

REMARKS:
1. In error situation, the data fields are filled with “#”.
2. *SmartView* will enter standby mode when the communication with the host is lost.
3. The data fields PV health, PV representation, and PV alarms are only visible if they are applicable.

4.1.5.1.10 Password Screen

The [commands] and [commissioning] menus are password-protected. The [password] screen (see FIGURE 4-9) appears when you enter the [commands] or the [commissioning] menu.

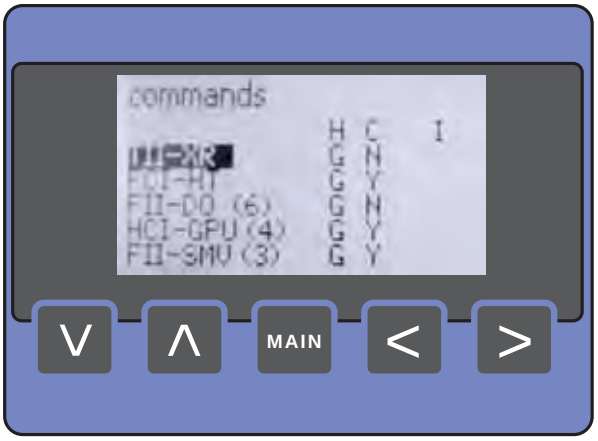
Once the password is entered correctly (only once will do for both menu entries), you can change the values. 15 minutes after the last button was pressed, the password needs to be re-entered.

ESF07-0040

FIGURE 4-9 The password screen

4.1.5.1.11 *Commands Menu Screens*

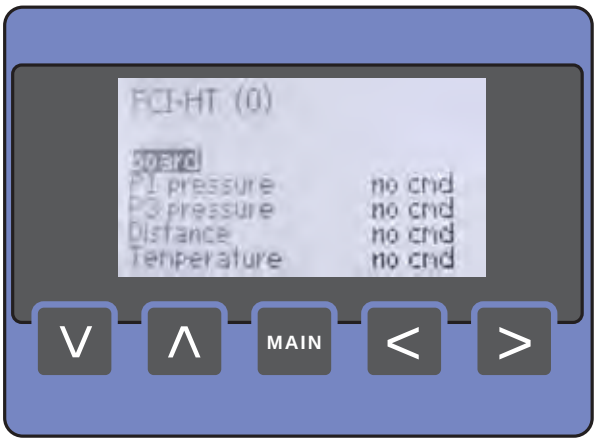
- The [commands] menu starts with the [board list] screen (see FIGURE 4-10).
  You can *navigate through the board list* by using the up and down buttons. A board can be selected by simultaneously pressing the left + right button.



ESF07-0034

FIGURE 4-10 The board list screen

- The [function list] screen (see FIGURE 4-11) shows all *available functions* of the previously selected board. You can navigate through the function list by using the up and down buttons. You can return to the [board list] screen by pressing the left button. A function can be selected by simultaneously pressing the left + right button. If a FlexConn module does *not* contain any function commands, this will be indicated in the list (<no cmd>).



ESF07-0045

FIGURE 4-11 The function list screen

- On selection of an available function, the [command list] screen is presented (see FIGURE 4-12). You can navigate through the

function list by using the up or down button. A command can be selected by simultaneously pressing the left + right button. You can return to the [function list] screen by pressing the left button.

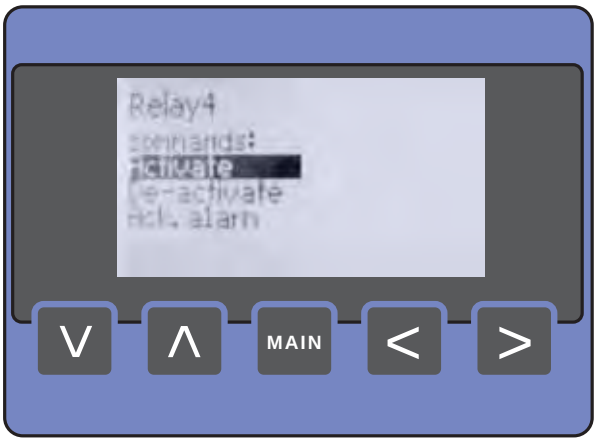


FIGURE 4-12 The command list screen

ESF07-0035

4.1.5.1.12 Commissioning Menu Screen

- The [commissioning] menu starts with the [board list] screen (see FIGURE 4-13).
  You can *navigate through the board list* by using the up or down button. A board can be selected by simultaneously pressing the left + right button.

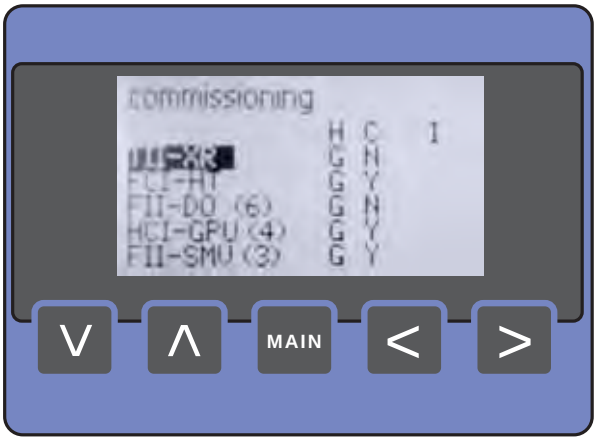


FIGURE 4-13 The board list screen (commissioning)

ESF07-0036

- The [function list] screen (see FIGURE 4-14) *displays all configurable entities* of a function.
  The actual entity value is visible as well.
  You can *navigate through the board list* by using the up or down button. A function can be selected by simultaneously pressing the left + right button. You can return to the [board list] screen by pressing the left button.

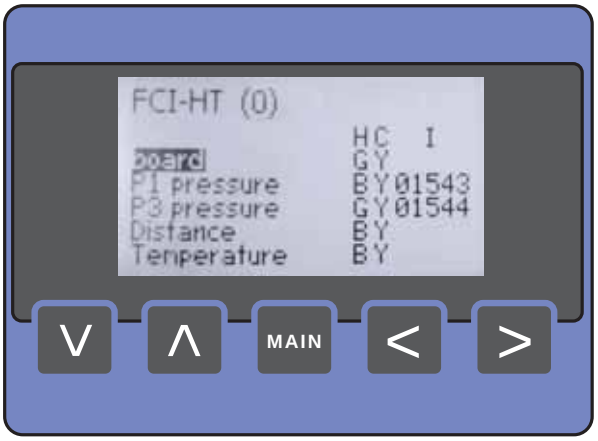


FIGURE 4-14 The function list screen (commissioning) ESF07-0046

- On selection of an available function, the [entity list] screen is presented (see FIGURE 4-15). You can *navigate through the entity list* by using the up or down button. An entity can be selected by simultaneously pressing the left + right button. You can return to the [function list] screen by pressing the left button.

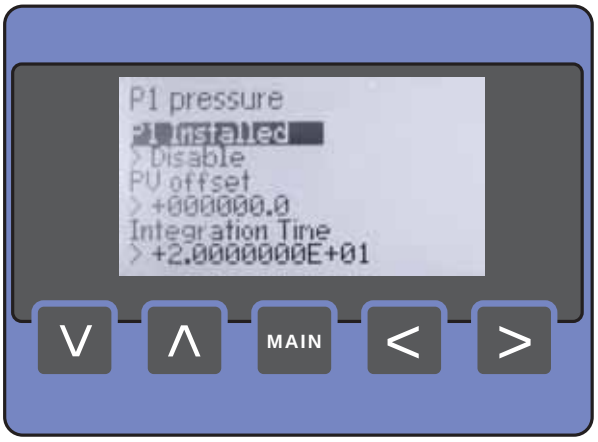


FIGURE 4-15 The entity list screen ESF07-0047

- On selection of an available entity, the [value edit] screen is presented (see FIGURE 4-16).
  - If an *invalid* value is entered, the message “value out of range” will be displayed.
  - If the value is *not accepted* by the FlexConn module, the message “value not accepted” will be displayed.
  - You can scroll along the characters by push and hold the up button.
  - An entity modification is only executed on simultaneously pressing the left + right button. After this, first a range check is done. If the modification is accepted, you will be returned to the [value edit] screen.
  - The cursor can be shift to the right by pressing the right button.
  - You can return to the [entity list] screen by pressing the left button.

*NOTE: By using the left button to return to the [entity list] screen **without executing** the modification(s) by pressing the left + right button simultaneously will undo this (these) modification(s)!*

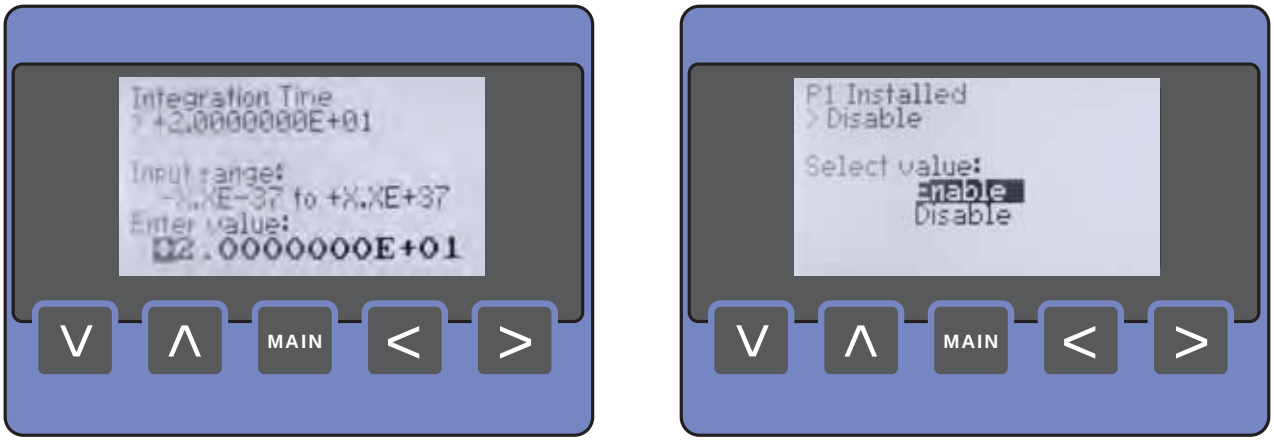


FIGURE 4-16 Examples of the value edit screen

ESF07-0037

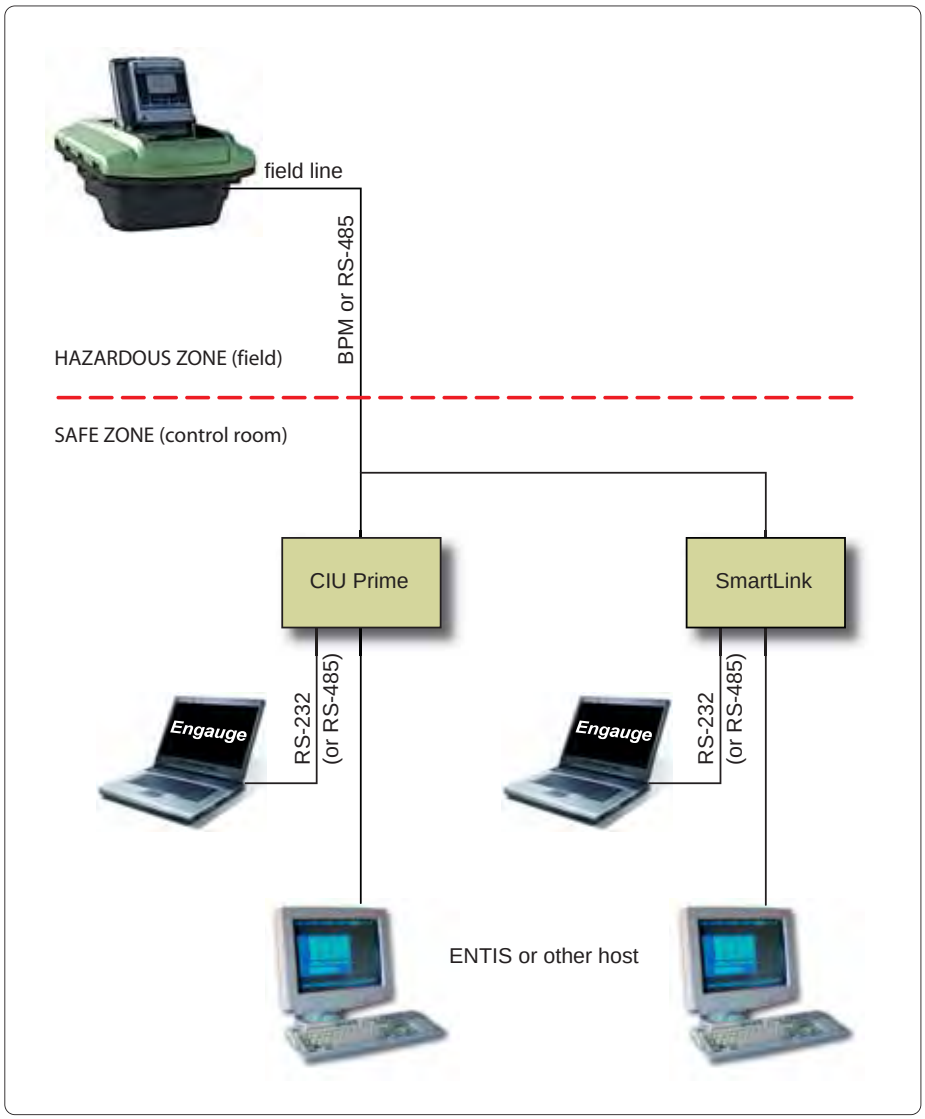
4.2 Engauge

4.2.1 Connecting the Engauge Service Tool

The *Engauge* service tool is a PC application with which all FlexConn module settings can be done as well.

4.2.1.1 Wired Connections Situation (FIGURE 4-17)

Connecting the serial COM-port of a PC or laptop via an RS-232 (or RS-485) transmission line to either a Communication Interface Unit (CIU) or a SmartLink, enables the control of a SmartRadar FlexLine system.



ESF07-0041

FIGURE 4-17 Connecting the *Engauge* service tool - wired connections

4.2.1.2 OneWireless Situation (FIGURE 4-18)

Connecting the serial COM-port of a PC or laptop via an RS-232 (or RS-485) transmission line and a Lantronix server, or directly via an Ethernet connection (*Engauge* version 2.4 and up only), to a OneWireless gateway enables the control of a OneWireless SmartRadar FlexLine system.

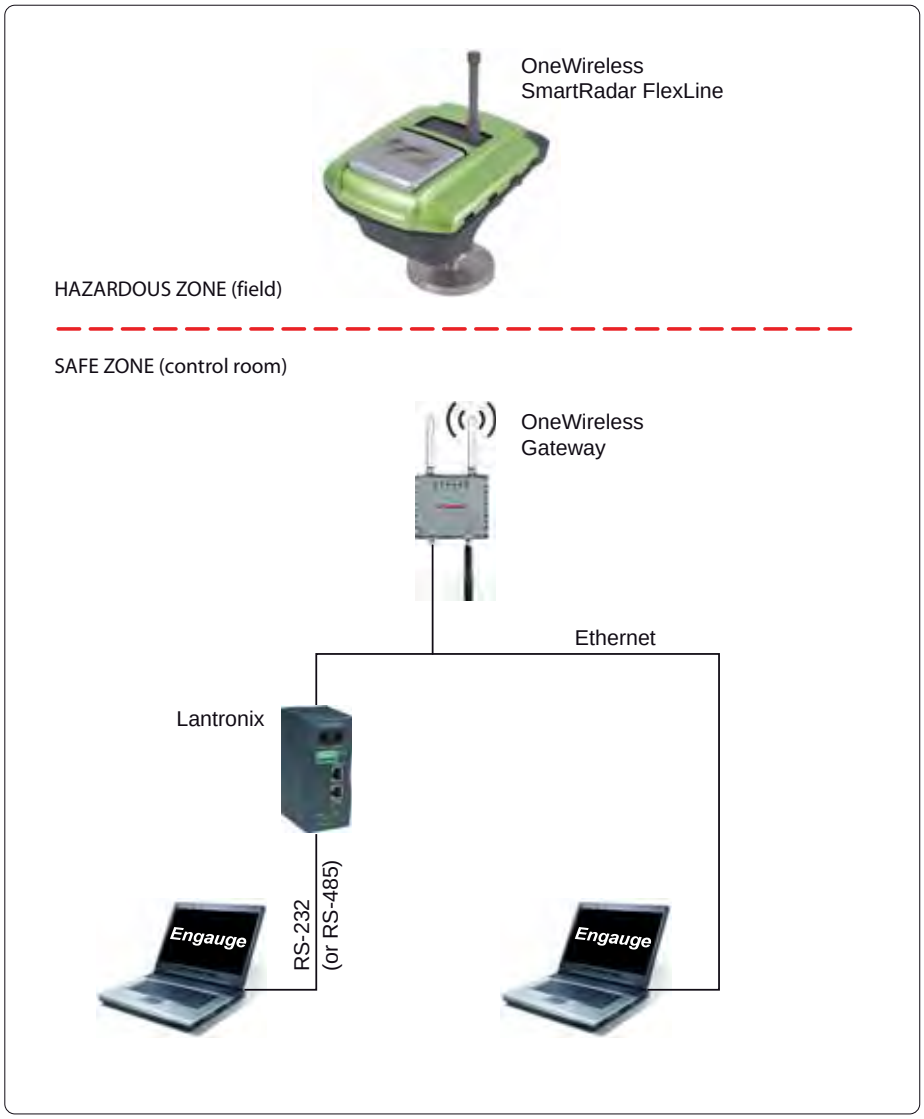


FIGURE 4-18 Connecting the Engauge service tool - OneWireless

ESF09-0010

4.2.2 Using Engauge

After starting up the *Engauge* application, first the specific transmission address of the concerned SmartRadar FlexLine system must be set correctly. Also the transmission speed (baudrate) must be set.

After this is done, *Engauge's* explorer appears, and each FlexConn module of the concerned SmartRadar FlexLine system is visible on the left panel. See FIGURE 4-19.

Now each individual SmartRadar FlexLine module can be controlled by double-clicking on the module's icon on the left panel. The so-called "board descriptor" is then loaded and a screen with "tab" pages appears.

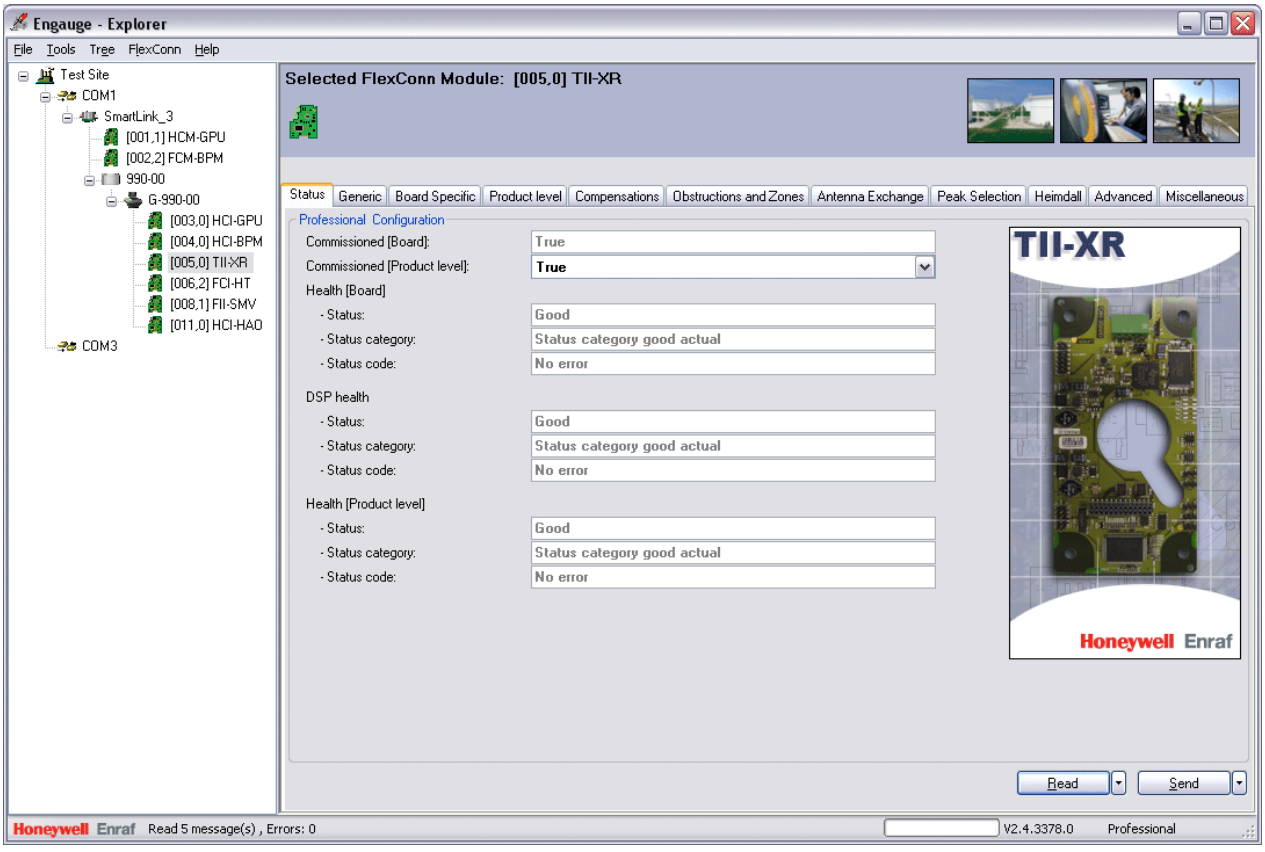


FIGURE 4-19 Example (1) of an *Engauge* screen

ESF09-0001

Browsing through the tab pages reveals the same information/ parameter settings as can be found using the *SmartView*, although in a more user friendly way.

However, some settings or commands can only be executed by *Engauge*. For example, executing an Alarm simulation test is only possible with *Engauge*.

4.2.3 Some Engauge Screen Examples

In the following some *Engauge* screen samples follow.

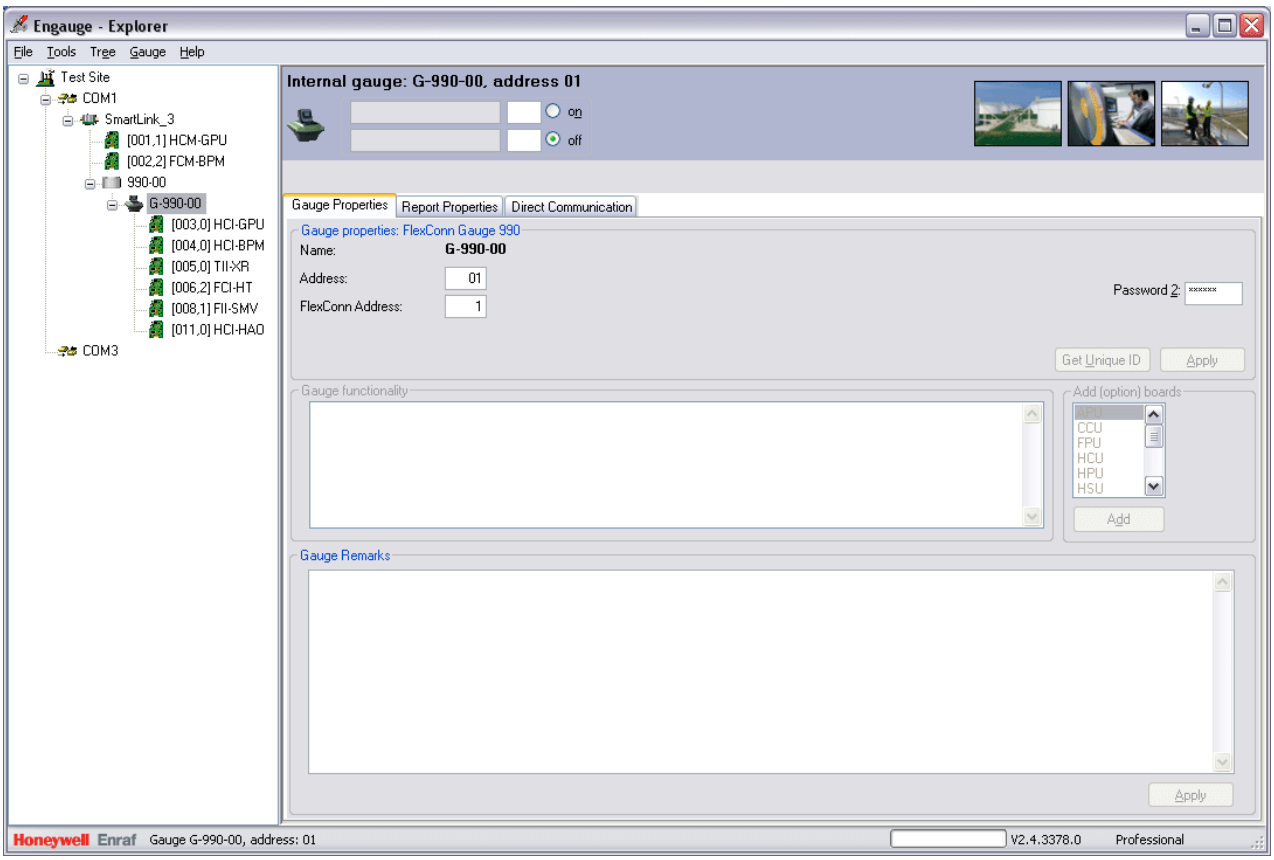


FIGURE 4-20 Example (2) of an *Engauge* screen

ESF09-0002

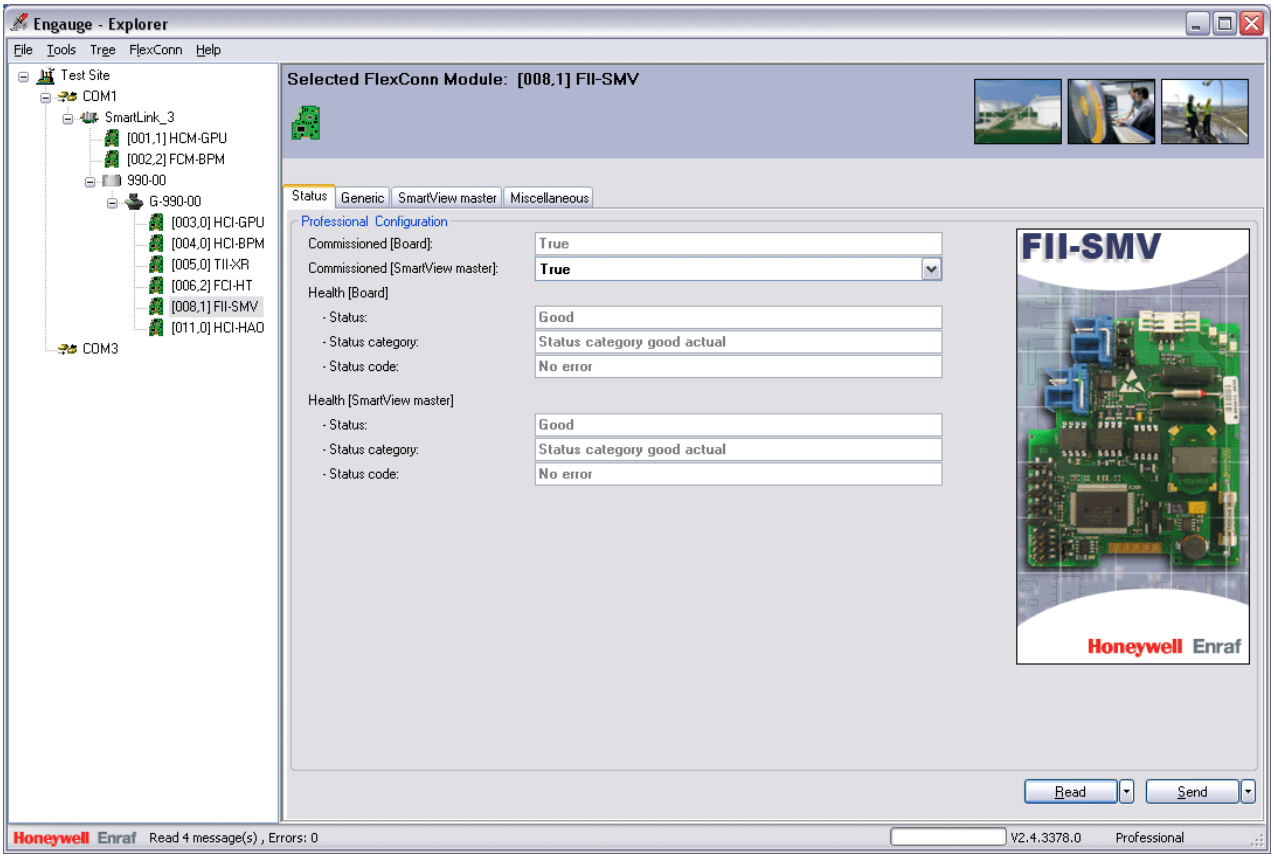


FIGURE 4-21 Example (3) of an *Engauge* screen

ESF09-0003

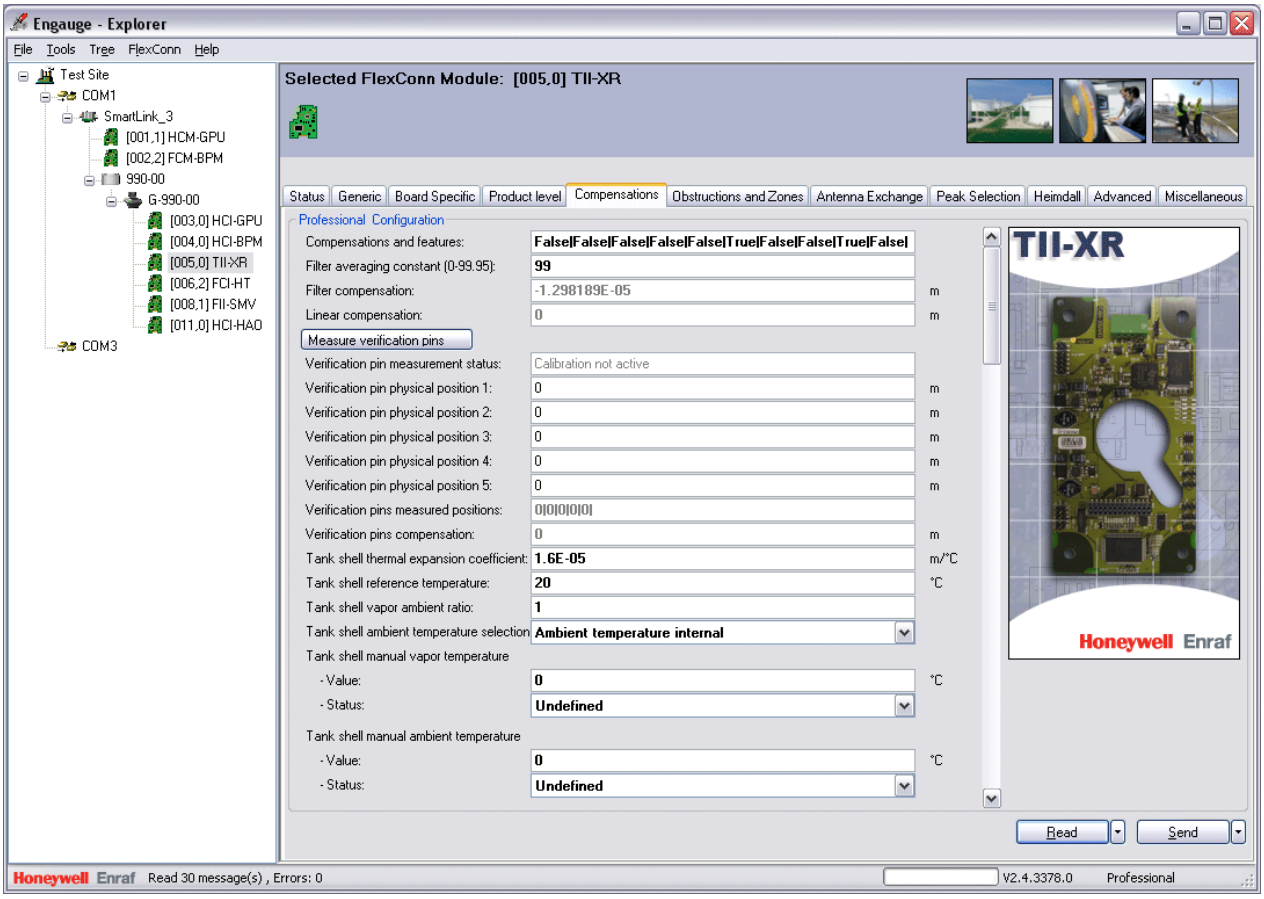


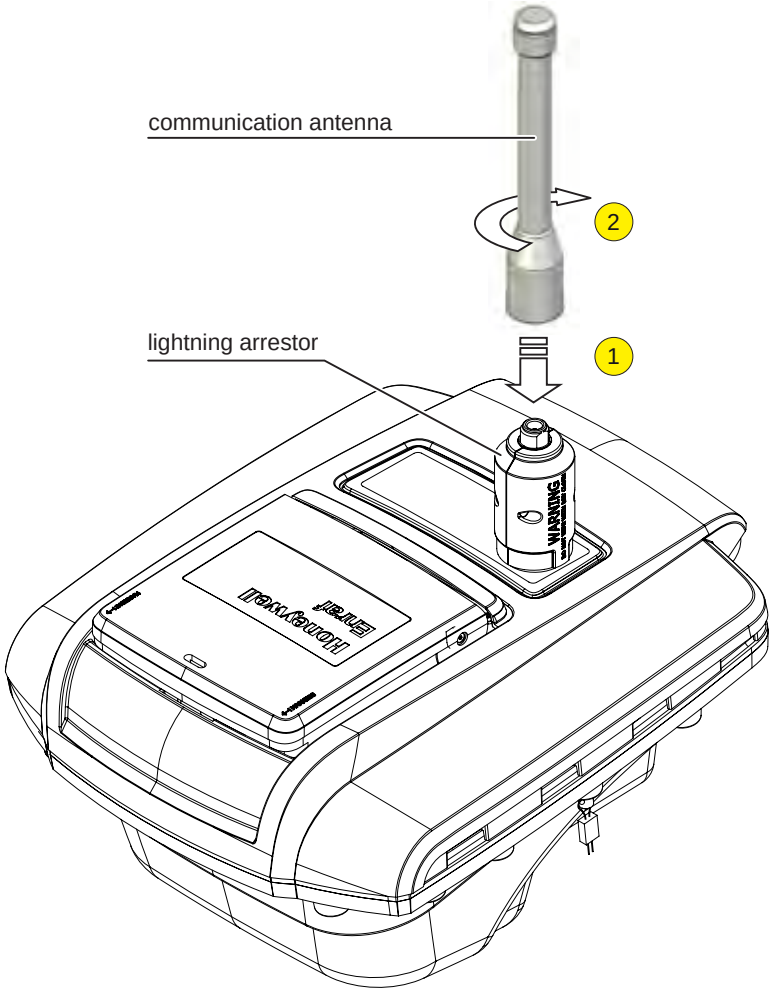
FIGURE 4-22 Example (4) of an *Engauge* screen

ESF09-0004

CHAPTER 5 INSTALLATION

- Before starting with commissioning activities, first **make sure all mechanical and electrical installation aspects have been completed correctly**.
- For installation, see the *Installation Guide* for the SmartRadar FlexLine.
- In case the **OneWireless Communication Option (HCI-1WL)** is installed, a **lightning arrestor** is integrated by default. The lightning arrestor (see figure below) will prevent the inside electronics from being affected in case of a nearby lightning strike. Although it will protect against multiple discharges, it can be replaced as a preventive maintenance action. Preventive maintenance interval depends on location, position of the equipment, grounding, and other protection measures installed.

NOTE: Contact our service department for any guidance if needed, via e-mail: enraf.helpdesk@honeywell.com



CHAPTER 6 COMMISSIONING

6.1 General

6.1.1 Introduction

This chapter gives an overview of the *commissioning* information per FlexConn module.

NOTE: Not all modules are always present.

Commissioning a FlexConn module is done by setting software parameters, the so-called *entities* (see Chapter 3), to the desired specific values. This can either be done by using *Engauge* or *SmartView* (see Chapter 4).

6.1.2 Text Conventions

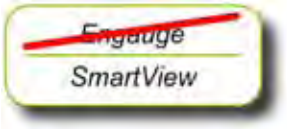
In contrast with explanatory text, all *instruction* text will be preceded by a ☛.

All [Entity] and <entity-related> text is recognizable formatted. When - for instance - all required FlexConn module entities are commissioned, the [Board Commissioned] entity will display <True>. If not, it will display <False>.

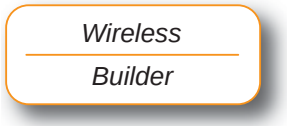
All !Command! text is also recognizable formatted, If - for instance - an !Activate! command is given, the result will be <Activated>.

In this chapter, each *commissioning-instruction* text is recognizable by the *Engauge/SmartView icon* in the margin.

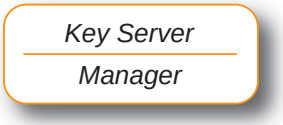
When a commissioning instruction or command *cannot* be initiated by *SmartView*, the icon will be given.



When a commissioning instruction or command can only be initiated via *SmartView*, the *SmartView-only button* is visible (left).



In some cases the *Wireless Builder* and/or the *Key Server Manager* application(s) are used. This is indicated by a corresponding button (left).



6.2 Enraf Fieldbus (HCI-BPM)

6.2.1 Introduction

The Host Communication Instrument - Bi-Phase Mark (HCI-BPM) board is a communication module for the instrument (gauge).

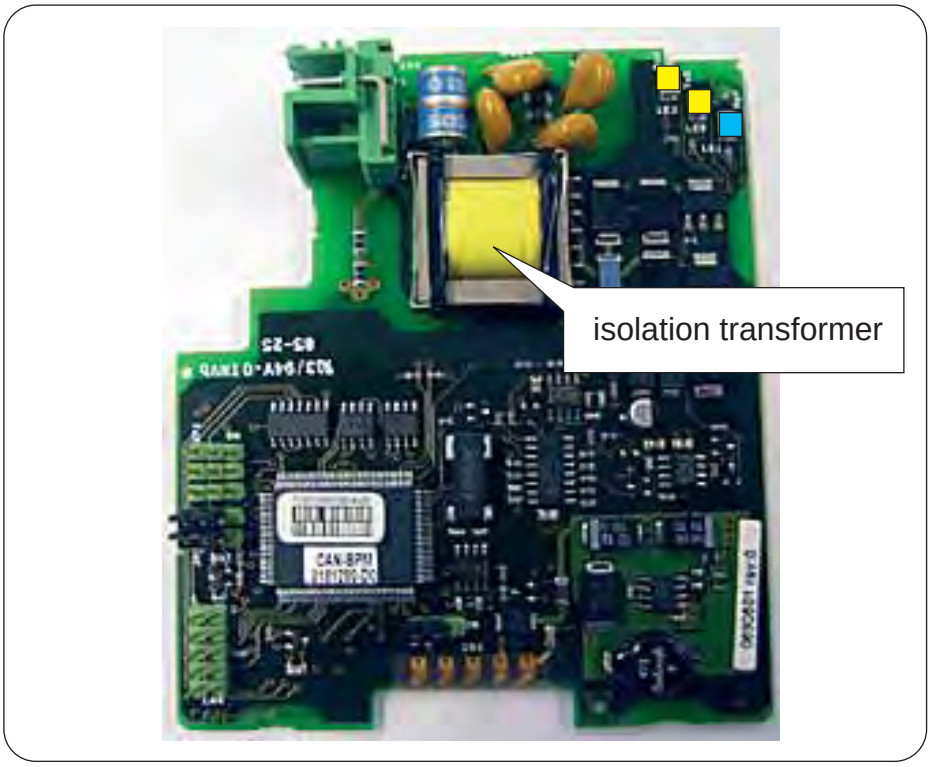


FIGURE 6-1 The HCI-BPM board with its isolation transformer

ESF07-0005

As a result of hardly any requirements on cable quality, the connection of 10 to 15 devices per field bus, and cable lenghts up to 10 km, the Bi-Phase Mark (BPM) signalling is used in many data transmission installations between various instrumentation and Communication Interface Unit (CIU) configurations.

Moreover, the BPM technology provides excellent protection against lightning. For the exchange of the BPM signals, the HCI-BPM board uses an isolation transformer for galvanic isolation (see FIGURE 6-1). Further protection against heavy lightning is realized by internal ground shields, separated wiring, and ground tracks.

The HCI-BPM module supports 2 protocols:

- The Enraf GPU protocol with its records and items (limited);
- The Enraf FlexConn protocol with its so-called entities.

The module can communicate with:

- 880 CIU prime
- 858 CIU
- 780 SmartLink

6.2.2 Commissioning the HCI-BPM

For a correct functioning of the HCI-BPM module within an instrument (gauge), the following entities can be set by using either *Engauge* or *SmartView*.

☛By using the following table, check each entity for correctness.

Name	Value Range	Default Value	Explanation
[Baudrate]	<1200> <2400> <4800>	<1200>	Communication speed
[BPM sensitivity]	<1..8>	<8>	The sensitivity of the receiver circuit 1 = weakest 8 = strongest
[Identification]	8 characters e.g. <TANK1234>	<-------->	Name of a tank or instrument
[GPU instrument address]	<0..99>	<0>	The address of this instrument for GPU messages. Note: Each instrument must have a unique GPU address.
[FlexConn instrument address]	<0..1899>	<0>	The address of this instrument for FlexConn messages. Note: Each instrument must have a unique FlexConn address.
[Level units]	<meters> <inches> <feet> <fractions>	<meters>	The unit in which level-related GPU records and items are shown
[Temperature units]	<celsius> <fahrenheit>	<celsius>	The unit in which temperature-related GPU records and items are shown

Name	Value Range	Default Value	Explanation
[Pressure units]	<pascal> <kilo pascal> <psi small> (2 digits before separator) <psi large> (3 digits before separator)	<pascal>	The unit in which pressure-related GPU records and items are shown
[Density units]	<kilogram m3> <degrees API> <pounds ft3>	<kilogram m3>	The unit in which density-related GPU records and items are shown
[Decimal separator]	<point> <comma>	<point>	The decimal separator in which GPU-related records and items are shown
[Level type]	<innage> <ullage>	<innage>	The level-related GPU records and items can be shown as an innage or ullage. Note: • *Innage* is the level of the product measured from the bottom. • *Ullage* is the level of free space from the roof till the product.
[Password]	<.....> 6 characters	<ENRAF2>	Password for entering the protected level. Note: Some settings reside under the protected level.
[Function identification]	<.....> 13 characters	<BPM-slave>	The name of the current function of this module. This name is visible on the *SmartView* display.

☛After having checked/set all before listed entities, make sure

- the [Board Commissioned] and the [BPM slave Commissioned] entities are <True>;
- the [Board Health] and the [BPM slave Health] entities are <GOOD>.

6.3 Enraf GPU-FlexConn / Modbus Protocol (HCI-GPU)

6.3.1 Introduction

The Host Communication Instrument - Gauge Processing Unit (HCI-GPU) board is a communication module for the instrument (gauge).

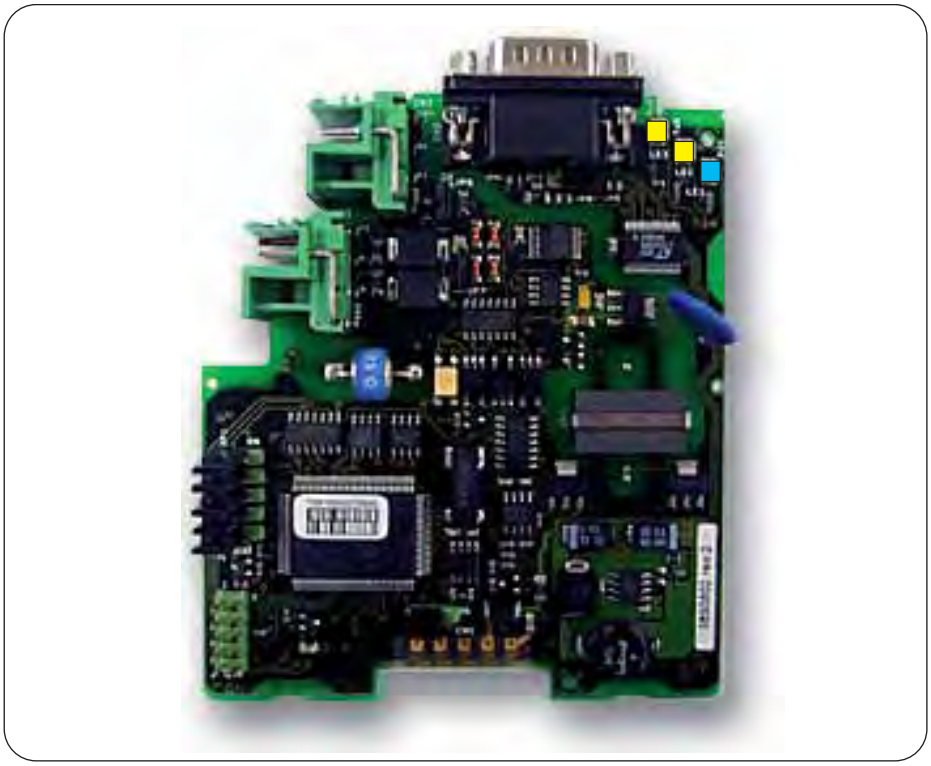


FIGURE 6-2 The HCI-GPU board ESF07-0006

The HCI-GPU can communicate with any hosts via three different communication protocols:

- The Enraf GPU protocol with its records and items (limited);
- The Enraf FlexConn protocol with its so-called entities;
- The Modbus protocol.

In the first situation the CAN-RS module behaves like an Enraf GPU slave, communicating via the Enraf GPU protocol. If a valid record or item is received, a related FlexConn message type A will be issued to the CAN-bus for obtaining the desired data.

In the second situation, when production-, test-, configuration-, and service tools are used, the FlexConn protocol must be used via the RS232/485 physical layer.

In the third situation the CAN-RS module behaves like a Modbus slave communicating via the Modbus protocol.

NOTE: A protocol switch has been implemented as to switch back and forward between the GPU-FlexConn and the Modbus protocol.

The physical layers for the communication are RS-232, isolated and non-isolated, and RS-485, isolated. RS-232 is used for direct point-to-point connections whereas RS-485 facilitates a multi-point network with up to 32 drivers and 32 receivers.

The HCI-GPU (slave) module can be used in any field devices provided with the FlexConn architecture.

The Modbus protocols can be used when the SmartRadar FlexLine interfaces to a DCS or SCADA system.

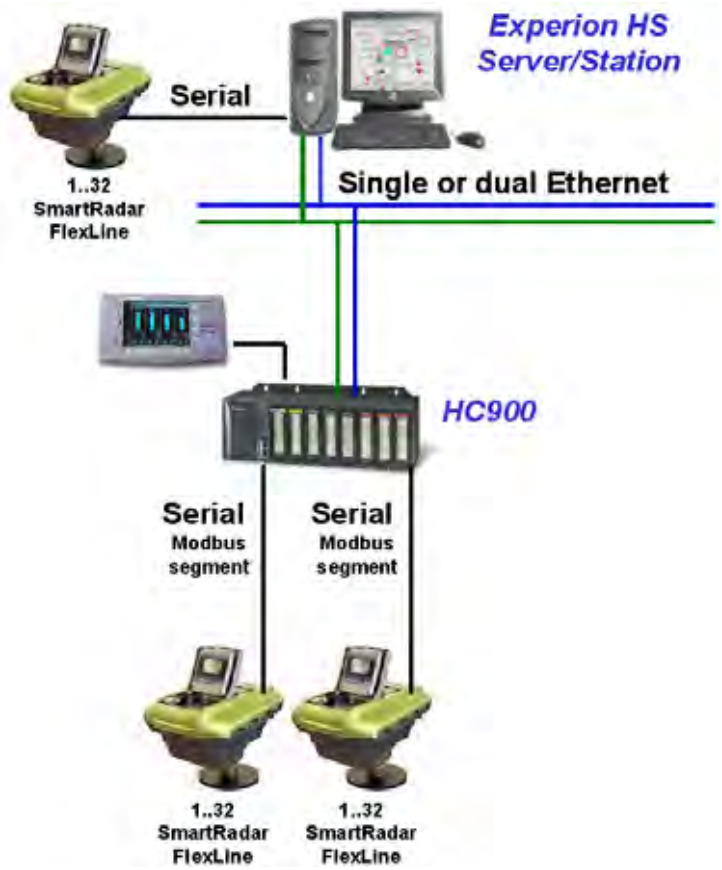


FIGURE 6-3 Typical example of a SmartRadar FlexLine in a Modbus topology

6.3.2 Specifications

- **System Specification**:
  - Typical TurnAround Delay (TAD) = 35 ms *
  - Maximum TAD = 65 ms *
  - Refresh rate of 32 FlexLines on one link = 5.76 sec * (@ scan rate of 180 ms)
  - Refresh rate of 32 FlexLines on one link = 4.80 sec * (free running host mode: no scan rate setting)
- **Recommended minimum host settings**:
  - Time out >= 65 ms * (assuming time out measurement resets at start of slave message)
  - Scan rate >= 180 ms *

* Note: @ 100 register @ 19K2 baud

6.3.3 Commissioning the HCI-GPU - Modbus Protocol

6.3.3.1 Introduction

The Modbus protocol has been developed by Modicon and is used to establish master-slave/client-server communication between intelligent devices. Modbus is a *de facto* open standard and the most widely used network protocol in the industrial manufacturing environment.

There are different flavors of Modbus. The most common is Modbus RTU (Remote Terminal Unit) which is based on serial (twisted pair) communication like RS-485 and RS-232. Honeywell Enraf has implemented this Modbus RTU protocol in its gauges as an option.

As with RS-485 communication a bus structure can be built, it is possible to connect a maximum of 32 gauges (as slaves) to one host (master). Each slave has its unique address.

The host (master) initiates the communication by addressing one of the slaves in its query. Only the addressed slave (gauge) will respond.

With RS-232 communication there can be only one slave (the gauge) and one master (the host).

6.3.3.2 Modbus Protocol Description

A Modbus message is placed by the transmitting device into a frame that has a known beginning and ending point.This allows receiving devices to begin at the start of the message, read the address portion and determine which device is addressed, and to know when the message is completed.

RTU mode is a binary mode of data representation. Messages start with a silent interval of at least 3.5 character times. This is most easily implemented as a multiple of character times at the baud rate that is being used on the network (shown as T1T2T3T4 in next figure).

The first field then transmitted is the device address. The gauges monitor the bus continuously, including during the silent intervals. When the first byte (the address byte) is received, each gauge decodes it to find out if it is the addressed gauge.

Following the last transmitted byte, a similar interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval.

A typical message frame is shown below:

Start	Address	Function	Data	CRC check	End
T1T2T3T4	8 bits	8 bits	n * 8 bits	2 * 8 bits	T1T2T3T4

- **Start**: Synchronisation 3.5 character time elapsed.
- **Address**: The address field of a message frame contains eight bits. The address must be within the range 1 to 247 (decimal). A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.
- **Function**: The function code field of a message frame contains eight bits. **With the Modbus protocol only function code 03 (read holding registers) and function code 05 (force single coil) are supported.** When a message is sent from a master to a slave the function code field tells the slave what kind of action to perform. For a normal response, the slave simply echoes the original function code.
- **Data**: The data field is constructed using sets of two 8 bit bytes (16 bit registers). The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. The data field of a response from a slave to a master contains the requested data.
- **CRC check**: The CRC check field contains a 16-bit value implemented as two eight-bit bytes. The error check value is the result of a CRC (**C**yclical **R**edundancy **C**heck) calculation performed on the message contents. The CRC field is appended to the message as the last field in the message.
- **End**: Synchronization 3.5 character time elapsed.

6.3.3.2.1 Function Codes

- **Function code 03: Read holding registers**
  Holding registers are located in the memory range (4)0000 ... (4) FFFFH. Register values can range from 0000 to FFFFH. Depending on the use, the registers contain a value or bit coded status in single (16 bit) or double (32 bit) register signed (two=s complement) or not signed.
  - The query message specifies the starting register and quantity of registers to be read:

Slave address	Function 03	Start address	No. of registers	CRC check
8 bits	8 bits	16 bits	16 bits	16 bits

- The register data in the response message is packed as two bytes:

Slave address	Function 03	Byte count (N)	Data	CRC check
8 bits	8 bits	8 bits	(N) x 8 bits	16 bits

- The amount of bytes N is double the amount of requested registers, because each register occupies two bytes.

Request		Response	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	03	Function	03
Starting Address Hi	00	Byte Count	06
Starting Address Lo	6B	Register value Hi (108)	02
No. of Registers Hi	00	Register value Lo (108)	2B
No. of Registers Lo	03	Register value Hi (109)	00
		Register value Lo (109)	00
		Register value Hi (110)	00
		Register value Lo (110)	64

■ **Function code 05 Write single coi**l

Coils are located in the memory range (0)0000 ... (0) FFFFH. The value of a coil can be forced to: FF00H = ON, or 0000H = OFF.

- The query message specifies the coil reference to be forced:

Slave address	Function 05	Coil address	Force data	CRC check
8 bits	8 bits	16 bits	16 bits	16 bits

- The normal response is an echo of the query, returned after the coil state has been forced:

Request		Response	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	05	Function	05
Output Address Hi	00	Output Address Hi	00
Output Address Lo	AC	Output Address Lo	AC
Output Value Hi	FF	Output Value Hi	FF
Output Value Lo	00	Output Value Lo	00

Slave address	Function 05	Coil address	Force data	CRC check
8 bits	8 bits	16 bits	16 bits	16 bits

6.3.3.3 Commisioning Notes

While commissioning, please keep the following in mind:

■ For **gauge configuration** --> FlexConn must be used.

■ For **data monitoring and certain gauge commands**--> Modbus can be used.

- A changeover is done by the **protocol switch**.

Protocol switching is bound to the following:

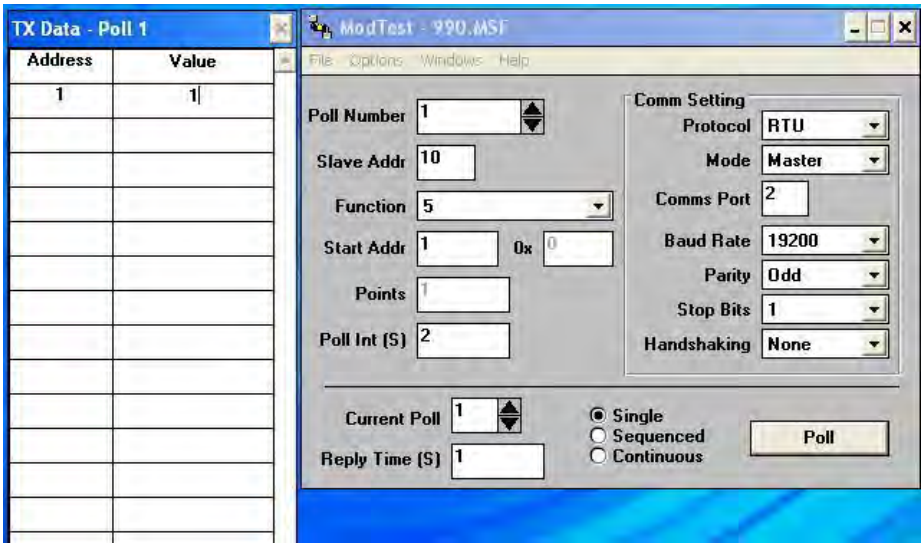
- **Engauge** only supports **GPU-FlexConn to Modbus** switching.
  Once the HCI-GPU is in Modbus mode, Engauge cannot execute any modifications as Engauge does NOT support Modbus communication.
  This scenario may be found at a first-time installation or during servicing issues.
- **SmartView** supports **both** GPU-FlexConn to Modbus and Modbus to GPU-FlexConn switching at any time, the actual protocol type being visible real time.
  Suitable on issues in the field.
- Along with data monitoring the **Modbus host** can issue certain commands such as Overfill test, Reset, Alarm Test, and **Modbus to GPU-FlexConn** switching.
- It is recommended to disconnect the SmartRadar FlexLine from the Modbus communication link when using Engauge with the GPU-FlexConn protocol.

Using ...	Switching possible from ...
Engauge	GPU-FlexConn --> Modbus
SmartView	GPU-FlexConn --> Modbus
	Modbus --> GPU-FlexConn
Modbus command	Modbus --> GPU-FlexConn

Example (with ModTest screen example of Daniel Europe Ltd. below):

To switch from Modbus to GPU-FlexConn, the following must be done:

- Set `Function = 5; Address = 1; Value = 1.`
- Activate by pressing the `Poll` button.



6.3.3.4 Commisioning

For a correct functioning of the HCI-GPU module within an instrument (gauge), the following entities can be set by using either *Engauge* or *SmartView*.

☛By using the following table, check each entity for correctness.

Name	Value Range	Default Value	Explanation
[FlexConn Modbus protocol switch]	<FlexConn-GPU> <Modbus>	<FlexConn-GPU>	If production-, test-, configuration-, and/or service tools are to be used, switch to the FlexConn protocol by selecting <FlexConn-GPU>.
[RS Baudrate]	<1200> <2400> <4800> <9600> <19200> <38400> <57600> <115200>	<19200>	Communication speed
[Turn around delay]	<0..2000 ms>	<0 ms>	The turnaround delay is the minimum time the HCI-GPU waits, before starting answering the host.
[Parity]	<Odd> <Even> <None>	<Odd>	User can have different parity depending upon application.
<Stopbits>	<One> <Two>	<One>	
[Modbus slave address]	<1..247>	<1>	On a site there can be multiple gauges connected via the RS-485 physical link and hence different CAN-RS boards can be identified by unique slave addresses. However, note that RS-485 supports **only 32 devices** in multidrop and so must be the addresses.

Name	Value Range	Default Value	Explanation
[Modbus register address offset]	<0x0000..0xEE00>	<0>	As per Modbus, function code 03 supports 0000 to FFFF register addressing. Considering modbus map starting at 0x0000 and 0x1000 and keeping this constant, the offset address should be (0xFFFF - 0x1138 = 0xEEC7) . For Round off number 0xEE00. Offset can be moved any where between 0x0000 to 0xEE00. 0x1138 is total number of registers of both modbus map.
[Level units]	<meters> <inches> <feet>	<meters>	The unit in which level-related records and items are shown
[Temperature units]	<celsius> <fahrenheit>	<celsius>	The unit in which temperature-related records and items are shown
[Pressure units]	<pascal> <kilo pascal> <psi>	<pascal>	The unit in which pressure-related records and items are shown
[Density units]	<kilogram m3> <degrees API> <pounds ft3>	<kilogram m3>	The unit in which density-related GPU records and items are shown
[Communication type]	<comm ni RS232> <comm iso RS232> <comm iso RS485>	<comm ni RS232>	Communication type *NOTE: must be configured at the GPU slave tab of Engauge. See 6.3.3.*
[Function identification]	<.....> 13 characters	<GPU-slave>	The name of the current function of this module. This name is visible on the *SmartView* display.
[Function priority]			

6.3.3.5 Modbus Holding Registers

Internal values in a Modbus device are stored in holding registers. These registers are two bytes wide and can be used for various purposes. Some registers contain configuration parameters where others are used to return measured values (temperatures etc.) to the host.

The holding registers start counting at 40001. They are addressed in the Modbus message structure with addresses starting at 0.

- The first table that follows contains all gauge data in **fixed point format** starting at **0x0000**. A **scaling factor** needs to be applied here.
- The second table contains all gauge data in **floating point format** starting at **0x1000**. **No scaling** to be applied here.
  - Floating point: IEEE-754
  - Signed integers: two's complement

6.3.3.5.1 Fixed Point Format Gauge Data

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Scaling factor	Interpretation
1	Product Level	0x0000	SD40001	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
	ProductLevelStatus	0x0002	40003	char	1			See 6.3.3.6.1
	ProductLevelAlarms	0x0003	40004	char	1			See 6.3.3.6.13
2	Water Level	0x0004	SD40005	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
	WaterLevelStatus	0x0006	40007	char	1			See 6.3.3.6.2
3	ProductTemp	0x0007	SD40008	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
	ProductTempStatus	0x0009	40010	char	1			See 6.3.3.6.3
4	VapRoomTemp	0x000A	SD40011	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
	VapRoomTempStatus	0x000C	40013..16	byte	4			See 6.3.3.6.4
5	VapRoomPress	0x0010	SD40017	long	2	PASCAL	multiply by 100	
						KILO_PASCAL	devide by 1000	
						PSI	devide by 1000	
	VapRoomPressStatus	0x0012	40019..23	byte	5			See 6.3.3.6.5
6	ObsDensity	0x0017	SD40024	long	2	KILOGRAM_PER_M3	devide by 100	
						POUNDS_PER_FT3	devide by 10000	
						DEGREES_API	devide by 1000	
	ObsDensityStatus	0x0019	40026..30	byte	5			See 6.3.3.6.6
7	Gauge Status	0x002A	40043	byte	1			See 6.3.3.6.14
8	Spot temperature 1	0x0200	SD40513	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
9	Spot temperature 1 pos.	0x0202	SD40515	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Scaling factor	Interpretation
10	Spot temperature 2	0x0204	SD40517	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
11	Spot temperature 2 pos	0x0206	SD40519	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
12	Spot temperature 3	0x0208	SD40521	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
13	Spot temperature 3 pos.	0x020A	SD40523	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
14	Spot temperature 4	0x020C	SD40525	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
15	Spot temperature 4 pos.	0x020E	SD40527	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
16	Spot temperature 5	0x0210	SD40529	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
17	Spot temperature 5 pos.	0x0212	SD40531	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
18	Spot temperature 6	0x0214	SD40533	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
19	Spot temperature pos. 6	0x0216	SD40535	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
20	Spot temperature 7	0x0218	SD40537	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
21	Spot temperature 7 pos.	0x021A	SD40539	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
22	Spot temperature 8	0x021C	SD40541	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
23	Spot temperature 8 pos.	0x021E	SD40543	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
24	Spot temperature 9	0x0220	SD40545	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
25	Spot temperature 9 pos.	0x0222	SD40547	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
26	Spot temperature 10	0x0224	SD40549	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Scaling factor	Interpretation
27	Spot temperature 10 pos.	0x0226	SD40551	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
28	Spot temperature 11	0x0228	SD40553	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
29	Spot temperature 11 pos.	0x022A	SD40555	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
30	Spot temperature 12	0x022C	SD40557	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
31	Spot temperature 12 pos.	0x022E	SD40559	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
32	Spot temperature 13	0x0230	SD40561	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
33	Spot temperature 13 pos.	0x0232	SD40563	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
34	Spot temperature 14	0x0234	SD40565	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
35	Spot temperature 14 pos.	0x0236	SD40567	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
36	Spot temperature 15	0x0238	SD40569	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
37	Spot temperature 15 pos.	0x023A	SD40571	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
38	Spot temperature 16	0x023C	SD40573	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
39	Spot temperature 16 pos.	0x023E	SD40575	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
40	Ambient Temperature	0x0300	SD40769	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
	Ambient TemperatureStatus	0x0302	40771	integer	1			See 6.3.3.6.7
41	Product Pressure	0x0303	SD40772	long	2	PASCAL	multiply by 100	
						KILO_PASCAL	devide by 1000	
						PSI	devide by 1000	
	Product PressureStatus	0x0305	40774	byte	5			See 6.3.3.6.8

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Scaling factor	Interpretation
42	Hart Input Variable 1	0x030A	SD40779	long	2	METRES	devide by 10000	
						FEET	devide by 1000	
						INCHES	devide by 100	
	Hart Input Variable 1 Status	0x030C	40781	Integer	1			See 6.3.3.6.9
43	Hart Input Variable 2	0x030D	SD40782	long	2	CELSIUS	devide by 100	
						FAHRENHEIT	devide by 100	
	Hart Input Variable 2 Status	0x030F	40784	Integer	1			See 6.3.3.6.9
44	Hart Input Variable 3	0x0310	SD40785	long	2	PASCAL	multiply by 100	
						KILO_PASCAL	devide by 1000	
						PSI	devide by 1000	
	Hart Input Variable 3 status	0x0312	40787	Integer	1			See 6.3.3.6.9
45	Hart Input Variable 4	0x0313	SD40788	long	2	KILOGRAM_PER_M3	devide by 100	
						POUNDS_PER_FT3	devide by 10000	
						DEGREES_API	devide by 1000	
	Hart Input Variable 4 status	0x0315	40790	Integer	1			See 6.3.3.6.9
46	Hart Input Variable 5	0x0316	SD40791	long	2	Free format	devide by 100	
	Hart Input Variable 5 status	0x0318	40793	Integer	1			See 6.3.3.6.9
47	First Relay Board - Relay 1	0x0319	SD40794	long	2			
	First Relay Board - Relay 1 Status	0x031B	40796	Integer	1			See 6.3.3.6.10
48	First Relay Board - Relay 2	0x031C	SD40797	long	2			
	First Relay Board - Relay 2 Status	0x031E	40799	Integer	1			See 6.3.3.6.10
49	First Relay Board - Relay 3	0x031F	SD40800	long	2			
	First Relay Board - Relay 3 Status	0x0321	40802	Integer	1			See 6.3.3.6.10
50	First Relay Board - Relay 4	0x0322	SD40803	long	2			
	First Relay Board - Relay 4 Status	0x0324	40805	Integer	1			See 6.3.3.6.10
51	Second Relay Board - Relay 1	0x0325	SD40806	long	2			
	Second Relay Board - Relay 1 Status	0x0327	40808	Integer	1			See 6.3.3.6.10
52	Second Relay Board - Relay 2	0x0328	SD40809	long	2			
	Second Relay Board - Relay 2 Status	0x032A	40811	Integer	1			See 6.3.3.6.10

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Scaling factor	Interpretation
53	Second Relay Board - Relay 3	0x032B	SD40812	long	2			
	Second Relay Board - Relay 3 Status	0x032D	40814	Integer	1			See 6.3.3.6.10
54	Second Relay Board - Relay 4	0x032E	SD40815	long	2			
	Second Relay Board - Relay 4 Status	0x0330	40817	Integer	1			See 6.3.3.6.10
55	Overfill Protection Status First Relay Board	0x0331	40818	char	1			See 6.3.3.6.12
56	Overfill Protection Status Second Relay Board	0x0332	40819	char	1			
57	Safety ShutDown Timer Left First Relay Board	0x0333	40820	Integer	1			
58	Safety ShutDown Timer Left Second Relay Board	0x0334	40821	Integer	1			
59	Analog Output	0x0335	SD40822	long	2	N.A.	devide by 100	
	Analog OutputStatus	0x0337	40824	integer	1			See 6.3.3.6.11
60	Tank Identification	0x0338	40825	char	8	N.A.		
61	GPU Device Number	0x0340	40833	integer	1			

6.3.3.5.2 Floating Point Format Gauge Data

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Interpretation
1	ProductLevel	0x1000	SD44097	floating point	2	METRES	
						FEET	
						INCHES	
	ProductLevelStatus	0x1002	44099	char	1		See 6.3.3.6.1
	ProductLevelAlarms	0x1003	44100	char	1		See 6.3.3.6.13
2	WaterLevel	0x1004	SD44101	floating point	2	METRES	
						FEET	
						INCHES	
	WaterLevelStatus	0x1006	44103	char	1		See 6.3.3.6.2
3	ProductTemp	0x1007	SD44104	floating point	2	CELSIUS	

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Interpretation
						FAHRENHEIT	
	ProductTempStatus	0x1009	44106	char	1		See 6.3.3.6.3
4	VapRoomTemp	0x100A	SD44107	floating point	2	CELSIUS	
						FAHRENHEIT	
	VapRoomTempStatus	0x100C	44109..12	byte	4		See 6.3.3.6.4
5	VapRoomPress	0x1010	SD44113	floating point	2	PASCAL	
						KILO_PASCAL	
						PSI	
	VapRoomPressStatus	0x1012	44115..19	byte	5		See 6.3.3.6.5
6	ObsDensity	0x1017	SD44120	floating point	2	KILOGRAM_PER_M3	
						POUNDS_PER_FT3	
						DEGREES_API	
	ObsDensityStatus	0x1019	44122..26	byte	5		See 6.3.3.6.6
7	Gauge Status	0x102A	44139	byte	1		See 6.3.3.6.14
8	Spot temperature 1	0x1200	SD44609	floating point	2	CELSIUS	
						FAHRENHEIT	
9	Spot temperature 1 pos.	0x1202	SD44611	floating point	2	METRES	
						FEET	
						INCHES	
10	Spot temperature 2	0x1204	SD44613	floating point	2	CELSIUS	
						FAHRENHEIT	
11	Spot temperature 2 pos.	0x1206	SD44615	floating point	2	METRES	
						FEET	
						INCHES	
12	Spot temperature 3	0x1208	SD44617	floating point	2	CELSIUS	
						FAHRENHEIT	
13	Spot temperature 3 pos.	0x120A	SD44619	floating point	2	METRES	
						FEET	
						INCHES	
14	Spot temperature 4	0x120C	SD44621	floating point	2	CELSIUS	
						FAHRENHEIT	
15	Spot temperature 4 pos.	0x120E	SD44623	floating point	2	METRES	
						FEET	
						INCHES	

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Interpretation
16	Spot temperature 5	0x1210	SD44625	floating point	2	CELSIUS	
						FAHRENHEIT	
17	Spot temperature 5 pos.	0x1212	SD44627	floating point	2	METRES	
						FEET	
						INCHES	
18	Spot temperature 6	0x1214	SD44629	floating point	2	CELSIUS	
						FAHRENHEIT	
19	Spot temperature 6 pos.	0x1216	SD44631	floating point	2	METRES	
						FEET	
						INCHES	
20	Spot temperature 7	0x1218	SD44633	floating point	2	CELSIUS	
						FAHRENHEIT	
21	Spot temperature 7 pos.	0x121A	SD44635	floating point	2	METRES	
						FEET	
						INCHES	
22	Spot temperature 8	0x121C	SD44637	floating point	2	CELSIUS	
						FAHRENHEIT	
23	Spot temperature 8 pos.	0x121E	SD44639	floating point	2	METRES	
						FEET	
						INCHES	
24	Spot temperature 9	0x1220	SD44641	floating point	2	CELSIUS	
						FAHRENHEIT	
25	Spot temperature 9 pos.	0x1222	SD44643	floating point	2	METRES	
						FEET	
						INCHES	
26	Spot temperature 10	0x1224	SD44645	floating point	2	CELSIUS	
						FAHRENHEIT	
27	Spot temperature 10 pos.	0x1226	SD44647	floating point	2	METRES	
						FEET	
						INCHES	
28	Spot temperature 11	0x1228	SD44649	floating point	2	CELSIUS	

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Interpretation
						FAHRENHEIT	
29	Spot temperature 11 pos.	0x122A	SD44651	floating point	2	METRES	
						FEET	
						INCHES	
30	Spot temperature 12	0x122C	SD44653	floating point	2	CELSIUS	
						FAHRENHEIT	
31	Spot temperature 12 pos.	0x122E	SD44655	floating point	2	METRES	
						FEET	
						INCHES	
32	Spot temperature 13	0x1230	SD44657	floating point	2	CELSIUS	
						FAHRENHEIT	
33	Spot temperature 13 pos.	0x1232	SD44659	floating point	2	METRES	
						FEET	
						INCHES	
34	Spot temperature 14	0x1234	SD44661	floating point	2	CELSIUS	
						FAHRENHEIT	
35	Spot temperature 14 pos.	0x1236	SD44663	floating point	2	METRES	
						FEET	
						INCHES	
36	Spot temperature 15	0x1238	SD44665	floating point	2	CELSIUS	
						FAHRENHEIT	
37	Spot temperature 15 pos.	0x123A	SD44667	floating point	2	METRES	
						FEET	
						INCHES	
38	Spot temperature 16	0x123C	SD44669	floating point	2	CELSIUS	
						FAHRENHEIT	
39	Spot temperature 16 pos.	0x123E	SD44671	floating point	2	METRES	
						FEET	
						INCHES	
40	Ambient Temperature	0x1300	SD44865	floating point	2	CELSIUS	
						FAHRENHEIT	
	Ambient TemperatureStatus	0x1302	44867	integer	1		See 6.3.3.6.7

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Interpretation
41	Product Pressure	0x1303	SD44868	floating point	2	PASCAL	
						KILO_PASCAL	
						PSI	
	Product Pressure Status	0x1305	44870	byte	5		See 6.3.3.6.5
42	Hart Input Variable 1	0x130A	SD44875	floating point	2	METRES	
						FEET	
						INCHES	
	Hart Input Variable 1 Status	0x130C	44877	Integer	1		See 6.3.3.6.9
43	Hart Input Variable 2	0x130D	SD44878	floating point	2	CELSIUS	
						FAHRENHEIT	
	Hart Input Variable 2 Status	0x130F	44880	Integer	1		See 6.3.3.6.9
44	Hart Input Variable 3	0x1310	SD44881	floating point	2	PASCAL	
						KILO_PASCAL	
						PSI	
	Hart Input Variable 3 status	0x1312	44883	Integer	1		See 6.3.3.6.9
45	Hart Input Variable 4	0x1313	SD44884	floating point	2	KILOGRAM_PER_M3	
						POUNDS_PER_FT3	
						DEGREES_API	
	Hart Input Variable 4 status	0x1315	44886	Integer	1		See 6.3.3.6.9
46	Hart Input Variable 5	0x1316	SD44887	floating point	2	Free format	
	Hart Input Variable 5 status	0x1318	44889	Integer	1		See 6.3.3.6.9
47	First Relay Board - Relay 1	0x1319	SD44890	floating point	2		
	First Relay Board - Relay 1 Status	0x131B	44892	Integer	1		See 6.3.3.6.10
48	First Relay Board - Relay 2	0x131C	SD44893	floating point	2		
	First Relay Board - Relay 2 Status	0x131E	44895	Integer	1		See 6.3.3.6.10
49	First Relay Board - Relay 3	0x131F	SD44896	floating point	2		
	First Relay Board - Relay 3 Status	0x1321	44898	Integer	1		See 6.3.3.6.10
50	First Relay Board - Relay 4	0x1322	SD44899	floating point	2		

Par.no.	Modbus parameter	Modbus address (hex)	Modbus Address (dec)	Data type	No. of registers	Conversion units	Interpretation
	First Relay Board - Relay 4 Status	0x1324	44901	Integer	1		See 6.3.3.6.10
51	Second Relay Board - Relay 1	0x1325	SD44902	floating point	2		
	Second Relay Board - Relay 1 Status	0x1327	44904	Integer	1		See 6.3.3.6.10
52	Second Relay Board - Relay 2	0x1328	SD44905	floating point	2		
	Second Relay Board - Relay 2 Status	0x132A	44907	Integer	1		See 6.3.3.6.10
53	Second Relay Board - Relay 3	0x132B	SD44908	floating point	2		
	Second Relay Board - Relay 3 Status	0x132D	44910	Integer	1		See 6.3.3.6.10
54	Second Relay Board - Relay 4	0x132E	SD44911	floating point	2		
	Second Relay Board - Relay 4 Status	0x1330	44913	Integer	1		See 6.3.3.6.10
55	Overfill Protection Status First Relay Board	0x1331	44914	char	1		See 6.3.3.6.12
56	Overfill Protection Status Second Relay Board	0x1332	44915	char	1		See 6.3.3.6.12
57	Safety Shutdown Timer Left First Relay Board	0x1333	44916	Integer	1		
58	Safety Shutdown Timer Left Second Relay Board	0x1334	44917	Integer	1		
59	Analog Output	0x1335	SD44918	floating point	2	N.A.	
	Analog Output Status	0x1337	44920	integer	1		See 6.3.3.6.11
60	Tank Identification	0x1338	44921	char	8	N.A.	
61	GPU Device Number	0x1340	44929	integer	1		

6.3.3.6 Status Information

After being requested so by the host, the slave will return the relevant status information. The following tables give the possible received status bytes from the relevant registers, such as product level, product temperature etc.

For a listing of ASCII codes, see 6.3.4.

6.3.3.6.1 Product Level

This register contains the bit-coded product level status. This status information is coded in such a way that an ASCII code for a character is generated. The ASCII characters are listed below.

Product Level status	Meaning
F	invalid level data
C	out of measuring range
B	measurement blocked
M	warning
?	reduced accuracy
-	valid product level

6.3.3.6.2 Water Level

This register contains the bit-coded water level status. This status information is coded in such a way that an ASCII code for a character is generated. The ASCII characters are listed below.

Water Level status	Meaning
F	invalid water alarm data
A	water above probe warning
Z	water below probe warning
-	valid water level

6.3.3.6.3 Product Temperature

This register contains the bit-coded product temperature status. This status information is coded in such a way that an ASCII code for a character is generated. The ASCII characters are listed below.

Product Temperature status	Meaning
F	invalid temperature alarm data
T	reduced accuracy
-	valid data

6.3.3.6.4 Vapour Room Temperature

Four registers contains the bit-coded vapour room temperature status. With exception of the first register, the status information is coded in

such a way that an ASCII code for a character is generated. The 8-bits ASCII coded character is placed in the Low byte of the register; the High byte remains empty (zero).

Vapour Room Temperature status	Meaning
0	indicating the highest immersed (spot)element of the temperature element
1	bit 0 - General temperature fail 1 - Fail in average product temperature 2 - Fail in average vapour temperature 3 - Level exceeds lowest (spot)element 4 - Level exceeds highest (spot)element 5 - (Spot)element fail 6 - one 7 - zero
2	bit 0 - Last valid level used 1 - Manual level used 2 - Level time out 3 - Device not calibrated (MTT) 4 - Exceeding differential temp. range (MTT) 5 - Out of specified temperature range 6 - one 7 - zero
3	bit 0 - No previous store command 1 - Alternative element selected (MRT) 2-5 - zero 6 - one 7 - zero

6.3.3.6.5 Vapour Room Pressure

Five registers contain the bit-coded vapour room pressure and observed density status. The status information is coded in such a way that an ASCII code for a character is generated. The 8-bits ASCII coded character is placed in the Low byte of the register; the High byte remains empty (zero).

Vapour Room Pressure status	Meaning
0	bit 0 - General option board fail 1 - Low level alarm 2 - Low low level alarm 3 - High level alarm 4 - High high level alarm 5 - Level time out 6 - one 7 - zero

Vapour Room Pressure status	Meaning
1	bit 0 - P1 exceeds min. / max. trip pressure 1 - P2 exceeds min. / max. trip pressure 2 - P3 exceeds min. / max. trip pressure 3 - Exceeding range P1 4 - Exceeding range P2 5 - Exceeding range P3 6 - one 7 - zero
2	bit 0 - Fail P1 1 - Fail P2 2 - Fail P1 3 - Manual P3 used 4 - Last valid P3 used 5 - Manual level used 6 - one 7 - zero
3	bit 0 - Last valid density used 1 - Manual density used 2 - High density alarm 3 - Low density used 4 - HTG level fail 5 - No previous store command 6 - one 7 - zero
4	bit 0 - Manual gas density used 1 - Level below LN 2 - Last valid level used 3 - Invalid level reading 4 - API underflow/overflow or negative density 5 - zero 6 - one 7 - zero

6.3.3.6.6 Observed Density

See 6.3.3.6.5 - Vapour Room Pressure.

6.3.3.6.7 Ambient Temperature

Health status code	Meaning
2561	LOWEST_ELEMENT_OFFSET_NOT_COMMISSIONED
2562	MRT_ELEMENT_LENGTH_NOT_COMMISSIONED
2563	MEASUREMENT_TYPE_NOT_COMMISSIONED
2564	ELEMENT_TYPE_NOT_COMMISSIONED
2565	NUMBER_OF_ELEMENTS_NOT_COMMISSIONED

Health status code	Meaning
2566	SECOND_ELEMENT_OFFSET_NOT_COMMISSIONED
2567	SENSOR_LENGTH_NOT_COMMISSIONED
2568	RTD_ELEMENT_POSITION_NOT_COMMISSIONED
2569	RTD_CONFIGURATION_NOT_COMMISSIONED
2570	MULTI_ELEMENT_OPTION_NOT_COMMISSIONED
2571	DYNAMIC_EXCLUSION_NR_OF_ELEMENTS_NOT_COMMISSIONED
2572	LOW_ELEMENT_USAGE_MEASUREMENT_TYPE_NOT_COMMISIONED
2573	TEMPERATURE_ELEMENT_EXCLUDE_ZONE_NOT_COMMISSIONED
2574	SMOOTHING_LEVEL_NOT_COMMISSIONED
2575	R_ELEMENT_SHORTCUT
2576	R_ELEMENT_NOT_CONNECTED
2577	T_ELEMENT_OUT_OF_RANGE
2578	ELEMENT_IN_WATER
2579	ELEMENT_FAIL
2580	NO_VALID_PRODUCT_LEVEL
2581	ELEMENT_SKIPPING
2582	NO_RELEVANT_ELEMENTS
2583	LEVEL_BELOW_LOWEST_ELEMENT
2584	NO_LAST_VALID_VALUE_AVAILABLE
2585	LEVEL_BELOW_TEMP_EXCLUDE_ZONE
2586	LEVEL_IN_TEMP_EXCLUDE_ZONE
2587	R_CABLE_OUT_OF_LIMITS
2588	R_TEST_OUT_OF_LIMITS
2589	VCC1_OUT_OF_LIMITS
2590	R_ELEMENT_INVALID_VALUE
2591	VOLTAGE_MON_PRIMARY_CIRCUIT_LO_LIM_EXCEEDED
2592	VOLTAGE_MON_PRIMARY_CIRCUIT_HI_LIM_EXCEEDED
2593	PROBE_RANGE_NOT_COMMISSIONED
2594	PROBE_OUT_OF_WNM_RANGE
2596	PRODUCT_LEVEL_NO_STATUS_CATEGORY_GOOD_ACTUAL

6.3.3.6.8 Product Pressure

See 6.3.3.6.5 - Vapour Room Pressure.

6.3.3.6.9 HART variable

Health status code	Meaning
1536	MORE_STATUS_AVAILABLE
1537	PV_OUT_OF_LIMITS
1538	SV_OR_TV_OUT_OF_LIMITS
1539	DEVICE_MALFUNCTION
1540	WRONG_PV_UNIT_CODE
1541	SCAN_INITIALIZING
1542	PRODUCT_LEVEL_SCAN_ERROR
1543	P1_NOT_INSTALLED
1544	P3_NOT_INSTALLED
1545	NO_P1_AVAILABLE
1546	NO_P3_AVAILABLE
1547	UNCERTAIN_P1
1548	UNCERTAIN_P3
1549	MANUAL_P1_USED
1550	MANUAL_P3_USED
1551	LAST_VALID_P3_USED
1552	NO_MANUAL_OR_LAST_VALID_P3
1553	NO_PRODUCT_LEVEL_AVAILABLE
1554	UNCERTAIN_PRODUCT_LEVEL
1555	PRODUCT_LEVEL_BELOW_MINIMUM_HIMS
1556	LAST_VALID_PRODUCT_LEVEL_USED
1557	MANUAL_PRODUCT_LEVEL_USED
1558	NO_WATER_LEVEL_AVAILABLE
1559	UNCERTAIN_WATER_LEVEL
1560	LAST_VALID_WATER_LEVEL_USED
1561	WATER_LEVEL_ABOVE_P1
1562	NEGATIVE_DENSITY_CALCULATED
1563	NO_MANUAL_OR_LAST_VALID_DENSITY
1564	MANUAL_WATER_LEVEL_USED
1565	DENSITY_OPTION_NOT_ENABLED
1566	P1_ERROR
1567	P3_ERROR
1568	G1_ERROR

Health status code	Meaning
1569	G2_ERROR
1570	G3_ERROR
1571	G4_ERROR
1572	G5_ERROR
1573	DENSITY_ERROR
1574	P1_UNCERTAIN
1575	P3_UNCERTAIN
1576	G1_UNCERTAIN
1577	G2_UNCERTAIN
1578	G3_UNCERTAIN
1579	G4_UNCERTAIN
1580	G5_UNCERTAIN
1581	DENSITY_UNCERTAIN
1582	TOO_MANY_HART_DEVICES_DETECTED
1583	WATER_LEVEL_SCAN_ERROR

6.3.3.6.10 Relay

Health status code	Meaning
2305	RELAY_TEST_FAILED
2307	PV_SCAN_VALUE_BAD
2308	PV_SCAN_VALUE_UNCERTAIN
2309	INVALID_MESSAGE_LENGTH
2310	NACK_CODE_RECEIVED
2311	ERROR_REQUESTING_ENTITY
2312	NO_BOARD_AVAILABLE
2313	ERROR_RELAY_1
2314	ERROR_RELAY_2
2315	ERROR_RELAY_3
2316	ERROR_RELAY_4
2317	LICENSE_NOT_SET
2318	REDUNDANT_BOARD_ERROR
2319	XBAND_OVERFILL_DISABLED

Health status code	Meaning
2320	NOT_COMMISSIONED
2321	BOARD_HEALTH_BAD
2322	REDUNDANT_BOARD_HEALTH_BAD
2323	REDUNDANT_BOARD_COM_FAIL
2324	SAFETY_TIMER_EXPIRED
2325	COMMISSIONING_MISMATCH
2326	RELAY_MODE_NOT_COMMISSIONED
2327	XBAND_BOARD_MISSING
2328	XBAND_LEVEL_BAD
2329	ALARM_MODE_NOT_COMMISSIONED
2330	MONITOR_BOARD_PARAMETERS_NOT_COMMISSIONED

6.3.3.6.11 Analog Output

Health status code	Meaning
2817	CALIBRATION_SET_POINTS_NOT_CALIBARTED
2818	POLLING_ADDRESS_SET_TO_NON_ZERO
2819	DAC_READ_BACK_FAIL
2820	AO_INITIALIZING
2821	BURNOUT_VALUE_OUT_OF_RANGE
2822	ANAOUT_FIXED_AT_4MA
2823	MULTI_DROP_MODE
2824	TUNNEL_FAILED_IN_GETTING_AN_ENTITY
2825	TUNNEL_FAILED_IN_PUTTING_AN_ENTITY
2826	UNITS_NOT_SELECTED
2827	LINKED_PV_NOT_SET
2828	LINKED_SV_NOT_SET
2829	LINKED_TV_NOT_SET
2830	LINKED_QV_NOT_SET
2831	PV_UNIT_CODE_NOT_SELECTED
2832	RANGE_VALUES_NOT_SELECTED
2833	PV_OUT_OF_LIMITS
2834	UPPER_TRANSDUCER_LIMIT_NOT_SET

Health status code	Meaning
2835	TRANSDUCER_SERIAL_NUMBER_NOT_SET
2836	UNABLE_TO_GET_LINKED_VARIABLE
2837	UPPER_RANGE_VALUE_GREATER_THAN_UPPER_TRANSDUCER_LIMIT
2838	LOWER_RANGE_VALUE_LESS_THAN_LOWER_TRANSDUCER_LIMIT

6.3.3.6.12 Overfill Protection Status

For a listing of ASCII codes, see 6.3.4.

Overfill Protection status	Meaning
O	Overfill
W	Warning
H	Healthy

6.3.3.6.13 Alarms

Product Level Alarm status	Meaning
0	no alarm
1	Low level product alarm tripped
2	High level product alarm tripped
3	Low low level product alarm tripped
4	High high level product alarm tripped
255	alarm failure

6.3.3.6.14 Gauge Status

The following table lists the Gauge status information and meaning.

Gauge status (decimal)	Meaning
0	Level gauge is measuring level
255	Level gauge is in failure

6.3.3.7 Modbus Coils

The following table lists Modbus commands and their related addresses (coils) and data.

Modbus command	Modbus address (hex)	Modbus address (dec)	Data	Number of registers
FlexConn Modbus Protocol Switch	0x00	00001	0xFF00	1
Reset Device	0x10	00017	0xFF00	1
Product Level Alarm Test Hi Hi	0x11	00018	0xFF00	1
Product Level Alarm Test Hi	0x12	00019	0xFF00	1
Product Level Alarm Test Lo	0x13	00020	0xFF00	1
Product Level Alarm Test Lo Lo	0x14	00021	0xFF00	1
Start Proof Test First Relay Board	0x15	00022	0xFF00	1
Stop Proof Test First Relay Board	0x16	00023	0xFF00	1
Start Proof Test Second Relay Board	0x17	00024	0xFF00	1
Stop Proof Test Second Relay Board	0x18	00025	0xFF00	1

NOTE: Coils are just names for memory addresses. The other way to look at it is that they are just pre-defined variable names. A coil is a boolean (bit) variable, and a register is an integer (word) variable.

6.3.3.8 Modbus Exception Handling

When a Modbus master device sends a request to a FlexLine device, it expects a normal response. One of four possible events can occur from the master's query:

- If the FlexLine device receives the request without a communication error, and can handle the query normally, it returns a normal response.
- If the FlexLine device does not receive the request due to a communication error, no response is returned. The master program will eventually process a timeout condition for the request. Typically 2 retries are carried out before going into fail.
- If the FlexLine device receives the request, but detects a communication error (parity, LRC, CRC), no response is returned. The master program will eventually process a timeout condition for the request.
- If the FlexLine device receives the request without a communication error, but cannot handle it (for example, if the request is to read a non–existent output or register), the FlexLine device will return an exception response informing the master of the nature of the error.

The exception-response message has two fields that differentiate it from a normal response:

- **Function** code field:
  In a normal response, the FlexLine device echoes the function code

of the original request in the function code field of the response. All function codes have a most–significant bit (MSB) of 0 (their values are all below 80 hexadecimal). In an exception response, the FlexLine device sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal higher than the value would be for a normal response.
With the function code's MSB set, the master's application program can recognize the exception response and can examine the data field for the exception code.

- **Data** field:
  In a normal response, the FlexLine device may return data or statistics in the data field (any information that was requested in the request). In an exception response, the FlexLine device returns an exception code in the data field. This defines the FlexLine device condition that caused the exception.

Code	Name	Meaning
01	Illegal Function	The function code received in the query is not an allowable action for the FlexLine device. This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the FlexLine device is in the wrong state to process a request of this type, for example because it is unconfigured and is being asked to return register values.
02	Illegal Data Address	The data address received in the query is not an allowable address for the FlexLine device. More specifically, the combination of reference number and transfer length is invalid.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for FlexLine device.

6.3.4 Standard ASCII codes

Dec	Oct	Hex	Binair	Code	Dec	Oct	Hex	Binair	Code	Dec	Oct	Hex	Binair	Code
32	040	20	0100000	SP	64	100	40	1000000	@	96	140	60	1100000	`
33	041	21	0100001	!	65	101	41	1000001	A	97	141	61	1100001	a
34	042	22	0100010	"	66	102	42	1000010	B	98	142	62	1100010	b
35	043	23	0100011	#	67	103	43	1000011	C	99	143	63	1100011	c
36	044	24	0100100	$	68	104	44	1000100	D	100	144	64	1100100	d
37	045	25	0100101	%	69	105	45	1000101	E	101	145	65	1100101	e
38	046	26	0100110	&	70	106	46	1000110	F	102	146	66	1100110	f
39	047	27	0100111	'	71	107	47	1000111	G	103	147	67	1100111	g
40	050	28	0101000	(	72	110	48	1001000	H	104	150	68	1101000	h
41	051	29	0101001	)	73	111	49	1001001	I	105	151	69	1101001	i
42	052	2A	0101010	*	74	112	4A	1001010	J	106	152	6A	1101010	j
43	053	2B	0101011	+	75	113	4B	1001011	K	107	153	6B	1101011	k
44	054	2C	0101100	,	76	114	4C	1001100	L	108	154	6C	1101100	l
45	055	2D	0101101	-	77	115	4D	1001101	M	109	155	6D	1101101	m
46	056	2E	0101110	.	78	116	4E	1001110	N	110	156	6E	1101110	n
47	057	2F	0101111	/	79	117	4F	1001111	O	111	157	6F	1101111	o
48	060	30	0110000	0	80	120	50	1010000	P	112	160	70	1110000	p
49	061	31	0110001	1	81	121	51	1010001	Q	113	161	71	1110001	q
50	062	32	0110010	2	82	122	52	1010010	R	114	162	72	1110010	r
51	063	33	0110011	3	83	123	53	1010011	S	115	163	73	1110011	s
52	064	34	0110100	4	84	124	54	1010100	T	116	164	74	1110100	t
53	065	35	0110101	5	85	125	55	1010101	U	117	165	75	1110101	u
54	066	36	0110110	6	86	126	56	1010110	V	118	166	76	1110110	v
55	067	37	0110111	7	87	127	57	1010111	W	119	167	77	1110111	w
56	070	38	0111000	8	88	130	58	1011000	X	120	170	78	1111000	x
57	071	39	0111001	9	89	131	59	1011001	Y	121	171	79	1111001	y
58	072	3A	0111010	:	90	132	5A	1011010	Z	122	172	7A	1111010	z
59	073	3B	0111011	;	91	133	5B	1011011	[	123	173	7B	1111011	{
60	074	3C	0111100	<	92	134	5C	1011100	\	124	174	7C	1111100	|
61	075	3D	0111101	=	93	135	5D	1011101	]	125	175	7D	1111101	}
62	076	3E	0111110	>	94	136	5E	1011110	^	126	176	7E	1111110	~
63	077	3F	0111111	?	95	137	5F	1011111	_	127	177	7F	1111111	DEL

6.4 The OneWireless Communication Option (HCI-1WL)

6.4.1 Introduction

The Host Communication Instrument OneWireless (HCI-1WL) board is a communication module for the instrument (gauge).

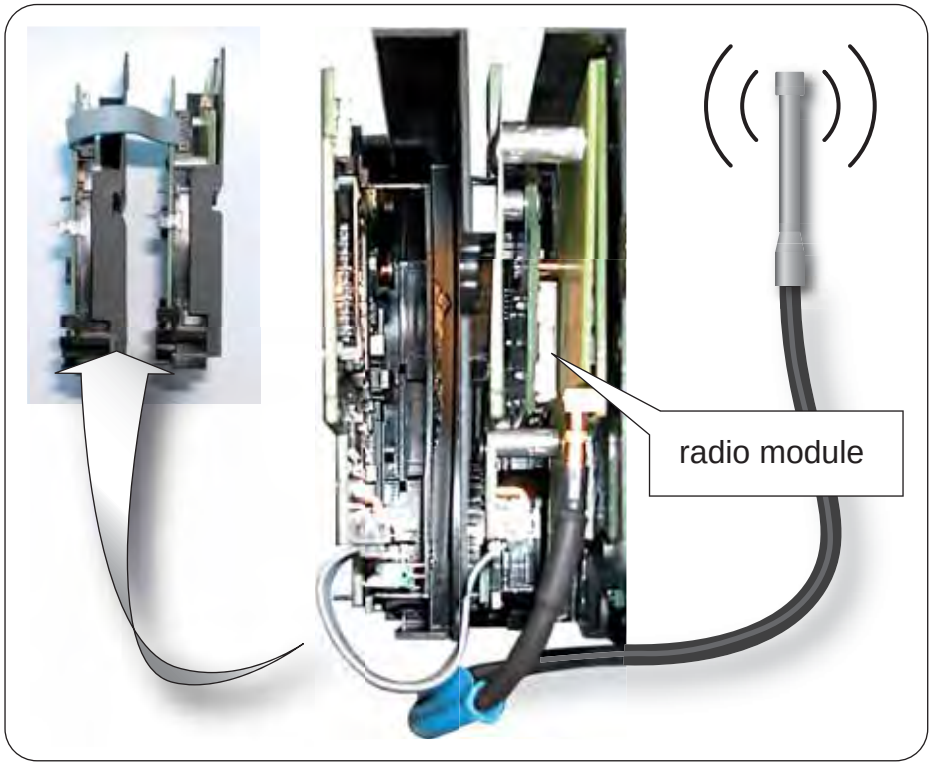


FIGURE 6-4 The HCI-1WL duplex board with flatcable interconnection ESF09-0011

This module consists of 2 boards (see FIGURE 6-4): a standard FlexConn board with a memory-card interface, and an interface board with a standard Honeywell OneWireless Radio board attached. If this wireless communication option is installed, the Instrument (gauge) can communicate with a host system using the OneWireless network via 3 different ways :

- Directly via the OneWireless Network (using the HCI-1WL board).
- By using a *protocol tunnel* through the OneWireless network:
  - Via the Enraf FlexConn Protocol.
  - Via the Enraf GPU protocol.

OneWireless is an all digital, two-way communication mesh network that interconnects industrial field sensors to a central system.

OneWireless has defined standards to which field devices and operator stations communicate with one another. The communications protocol

is built as an "open system" to allow all field devices and equipment that are built to the OneWireless standard to be integrated into a system, regardless of the device manufacturer. This interoperability of devices using OneWireless technology is to become an industry standard for automation systems.

In the Onewireless network, devices like the Smartradar FlexLine publish their measuring values autonomously at the network. Via an OPC server connected to gateway(s), the data is made available for further use.

The Honeywell Enraf GPU and FlexConn protocols are implemented for communication with Honeywell Enraf Tank Inventory Software systems like Entis Pro, Entis XL, and Entis XS. Additionally, these protocols enable communication with configuration and diagnostic tools such as *Engauge*. These protocols are implemented in the same way as in the HCI-GPU and HCI-BPM. Therefore they only support the same limited set of GPU records and so-called items.

6.4.2 Potential Electrostatic Charging Hazard

WARNING! Do NOT wipe the surface of the antenna with dry cloth, and do NOT clean its surface with a solvent.

If electrostatically charged, discharge of the antenna surface to a person or a tool could ignite a surrounding hazardous atmosphere.

6.4.3 Adding a Radar to the OneWireless Network

6.4.3.1 Introduction

Before a radar will be visible in the OneWireless network, it must be supplied with a correct network security key, so it will be allowed to join the protected wireless network.

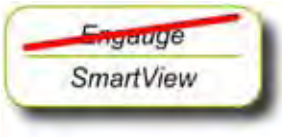
Users must be properly trained in Honeywell OneWireless solutions before adding the SmartRadar in a OneWireless network. To establish communication with the Onewireless network the *Key Server Manage*r and *Wireless Builder (R120 or later)* tools are required. Please refer to the respective manuals for details.

*CAUTION! **France** restricts outdoor use to 10mW (10 dBm) EIRP in the frequency range of 2,454-2,483.5 MHz. Installations in France must limit EIRP to 10 dBm for operating modes utilizing frequencies in the range of 2,454 – 2,483.5MHz. For this reason, Honeywell Enraf does not recommend configuring frequency hopping modes that use this frequency range.*

***For installations in France, use only the following OneWireless Frequency Hopping (FH) Mode Selections:** EU Channel #1, EU Channel #7, NA/EU Guard Bands and NA/EU Channel 3 (FH Mode selections #4, 5, 8 and 10).*

6.4.3.2 Preparing the Radar

Before adding a radar to a one wireless Network, old security information must be removed from the radar. To prevent this from happening by accident, this functionality is only available via the *SmartView*. To erase the security information:



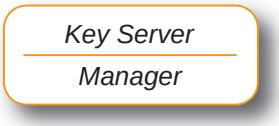
☛ Go to [Menu] > [Commands]

☛ Enter the password

☛ Go to the HCI-1WL

☛ Select [Board] and issue the [Restore Default] command.

6.4.3.3 Authentication



☛ Ensure the OneWireless Network is operational, including running Key Server Manager (KSM) software, and at least 1 multi-node configured as gateway.

☛ Use the KSM to write security information to a memory card. See the Key Server Manager manual for instructions on how to use the key server. For a sample screen, see FIGURE 6-5.

☛ Insert the memory card into the memory card slot of the HCI-1WL device.

☛ Make sure to fully close the device if it is installed in an explosion hazardous area.

☛ Switch on the device

The device will now automatically join the OneWireless network.

You can follow the authentication/joining process by navigating to the correct page on the *SmartView*, see 6.4.8.1. Or by using *Engauge*, see 6.4.9.1, if there is also a wired connection available.

If the message [NOREDUN] or [CONNECT] does NOT become visible, the authentication failed.

☛ If authentication failed, verify that the wireless network is operating correctly, and try again with a new security key.

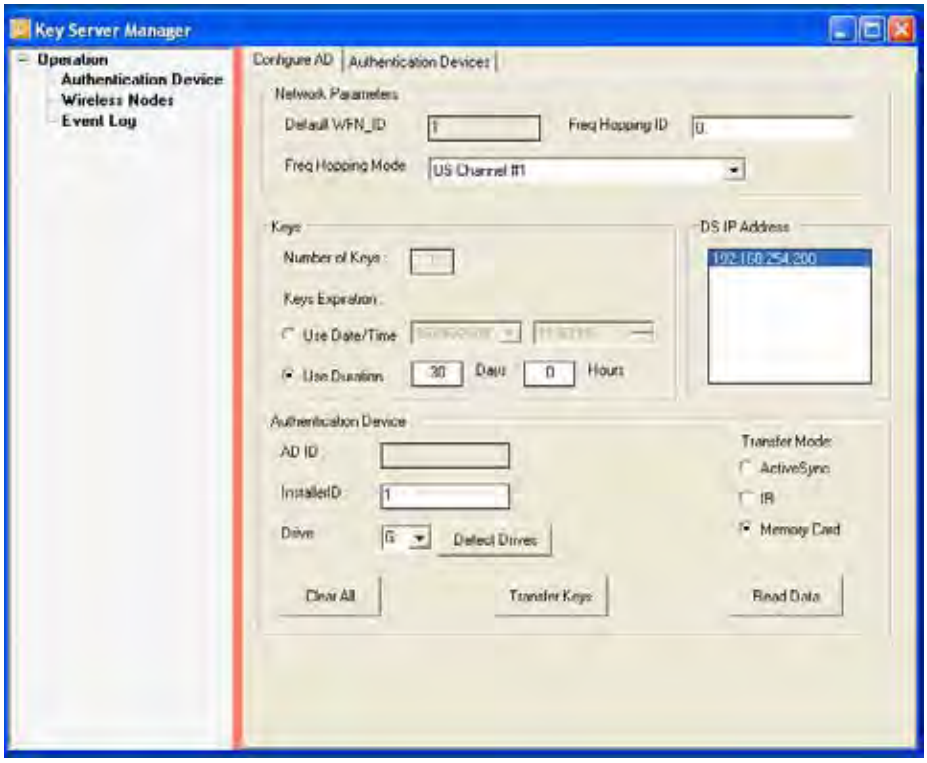
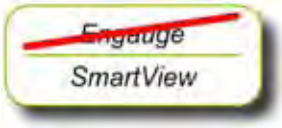


FIGURE 6-5 Sample screen of the Key Server Manager

6.4.4 Removing a Radar From the OneWireless Network

To remove a radar from a Onewireless Network, the security key information must be removed from the radar. To prevent this from happening by accident, this functionality is only available via the *SmartView*.

To erase the security key information:



☛ Go to [Menu] > [Commands]

☛ Enter the password

☛ Go to the HCI-1WL

☛ Select [Board] and issue the [Restore Default] command.

6.4.5 Commissioning the HCI-1WL in the OneWireless Network

6.4.5.1 Introduction

Once the authentication process is completed, the SmartRadar can be commissioned in the OneWireless network.

Before you continue with this step, ***familiarize yourself with the Wireless Builder configuration tool*** for the OneWireless network. For a detailed operation guide for the Wireless Builder, please refer to the ***OneWireless Wireless Builder User's Guide, R120 or later***.

With the Wireless Builder you can create, delete, commission, load, and unload the SmartRadar just like any other OneWireless devices. You can also activate and inactivate transducer blocks, and program the different parameters, such as publication period, as with any other devices.

Once the Authentication process has been successfully completed, the SmartRadar will automatically be listed in the *Online* window of Wireless Builder as an *uncommissioned device*.

With a *right mouse click* it can be commissioned as described in the Wireless Builder manual.

After having finished all steps before, the SmartRadar will have *one transducer block: Radar Level*.

During further commissioning, more transducer blocks can be added.

6.4.5.2 Transducer Blocks

6.4.5.2.1 Introduction

Besides the Radar Level transducer block, up to 16 additional transducer blocks can be added to the device via Wireless Builder. This can easily be done by *"drag and drop"*.

The specific parameters of all available transducer blocks can be set via Wireless Builder. This section describes how to use the Configuration Form to configure the transducer blocks (channels).

Please refer to the *Configuring Channels* chapter in the OneWireless manual. ***This Transducer Blocks section only explains the additional or non-standard items.***

6.4.5.2.2 Adding Transducer Blocks

In order to configure each channel, a user must add transducer blocks to this device.

Wireless Builder

☛ Expand the device template in the *Library* tree (click +), to see all available transducer blocks.

☛ Drag and drop the transducer block(s) that must be instantiated (= made concrete) from the Library tree to the device in the *Offline* tree.

*NOTE: Each transducer block can only be added to the instrument **once**.*

☛ After adding the relevant transducer block(s), load the device to *activate* the transducer blocks.

NOTE: Please refer to Block instantiation in the OneWireless Wireless builder User's Guide for more information.

The following additional transducer blocks are available:

Transducer Block	See section
Ambient temp	-
Average product temperature	-
Configurable Transducer block 1	6.4.5.2.5
Configurable Transducer block 2	
Configurable Transducer block 3	
Configurable Transducer block 4	
Observed Density	-
Product pressure	-
Relay output 1	6.4.5.2.7
Relay output 2	
Relay output 3	
Relay output 4	
Temperature Details	6.4.5.2.6

Transducer Block	See section
Vapour pressure	-
Vapour temperature	-
Water level	-

All Transducer blocks can be loaded for any SmartRadars. However a transducer block will ***only give valid data when a relevant option is installed in the SmartRadar***.

So for temperature transducer blocks to become actual available, an FII-RTD or FII-VT must be installed in the SmartRadar, and for the Relay output transducer blocks to work correctly, an FII-DO must be installed etc.

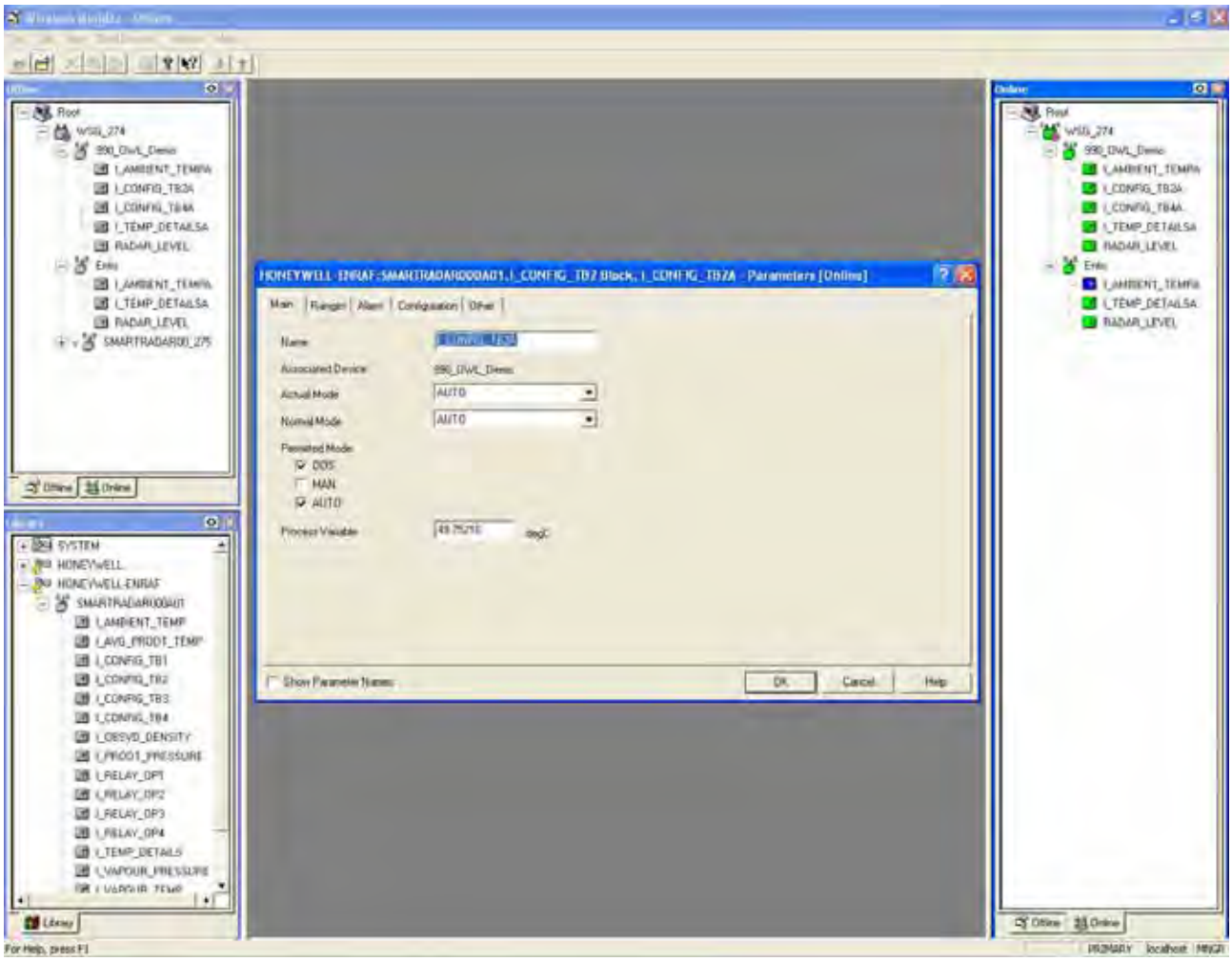
6.4.5.2.3 General Transducer Block Settings

By clicking on a transducer block of an instrument in the *Online* window, a window pops up with more details for this transducer block.

6.4.5.2.4 Wireless Builder Screens

6.4.5.2.4.1 Main Tab

This tab contains the general settings of the Transducer Block (TB).

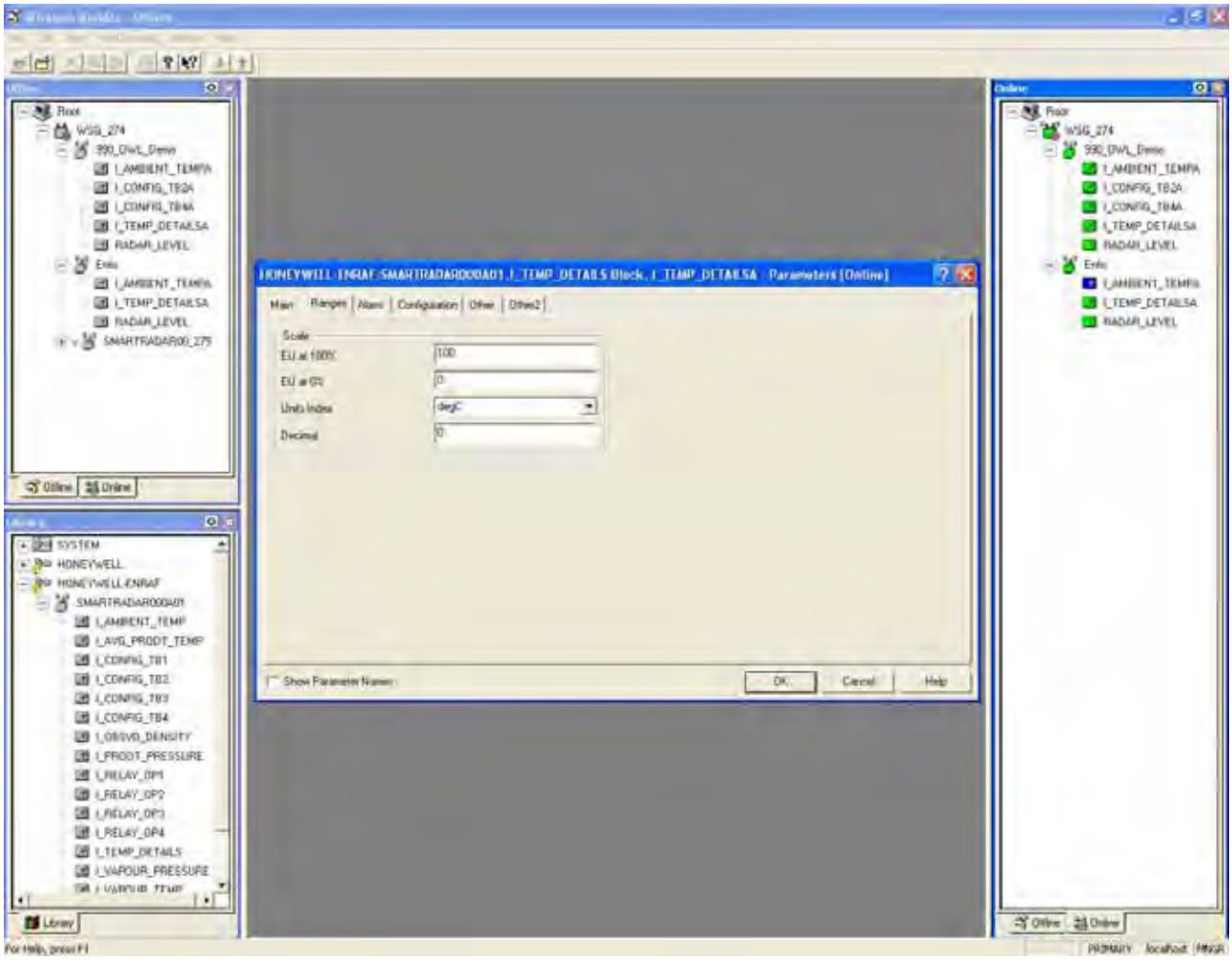


Parameter	Description
Name	Here you can specify the name of the transducer block.
Associated Device	The device that contains the transducer block you are editing. The device name is set during commissioning with Wireless Builder and is stored in the TAG descriptor entity.
Actual Mode	The actual operation mode of the transducer block. This may differ from the normal mode, for example if the device is Out of Service.
Normal Mode	This is the mode the transducer block should be in, in normal situations.

Parameter	Description
Permitted Mode	With these check boxes you can select the permitted modes for the transducer block.
Process Variable	If the transducer block is set to manual mode, you can manually overwrite the parameter (such as level). This is not standard within OneWireless. The manual value entered here will also be available in the FlexConn environment. If the Transducer block is not in Manual mode an error code will be generated after pressing the OK button.

6.4.5.2.4.2 Ranges Tab

This tab contains the settings for Engineering units.

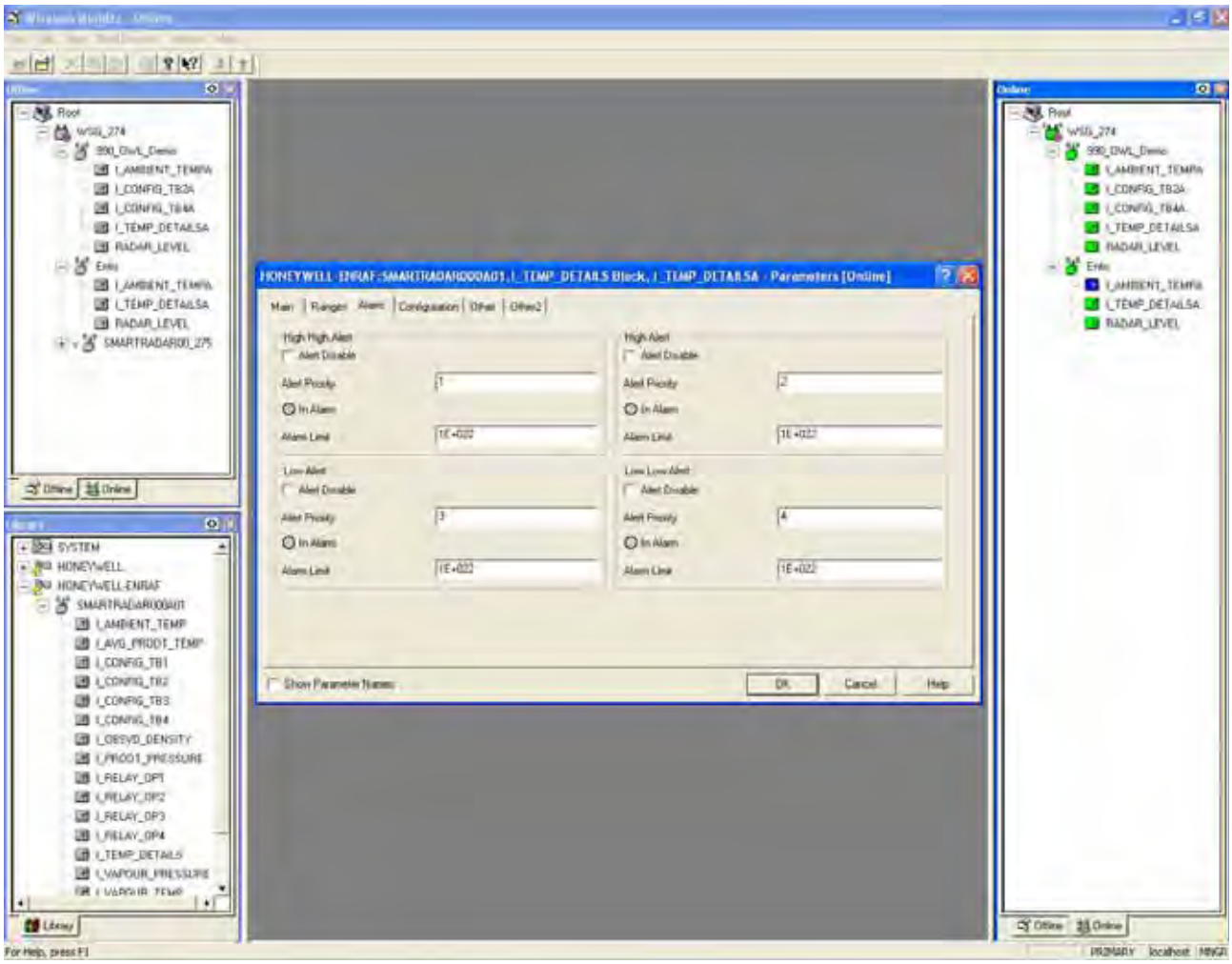


Parameter	Description
EU at 100%	Not used in The SmartRadar FlexLine
EU at 0%	Not used in The SmartRadar FlexLine
Units Index	In this field you can select the required engineering unit from the list of available units. (Level units for the level TB, and temperature units for the Temperature TB) Note: For supported units, see 6.4.5.2.8.

Parameter	Description
Decimal	Not used in The SmartRadar FlexLine

6.4.5.2.4.3 Alarm Tab

This tab contains the various alarm settings (High high, High, Low, and Low low).



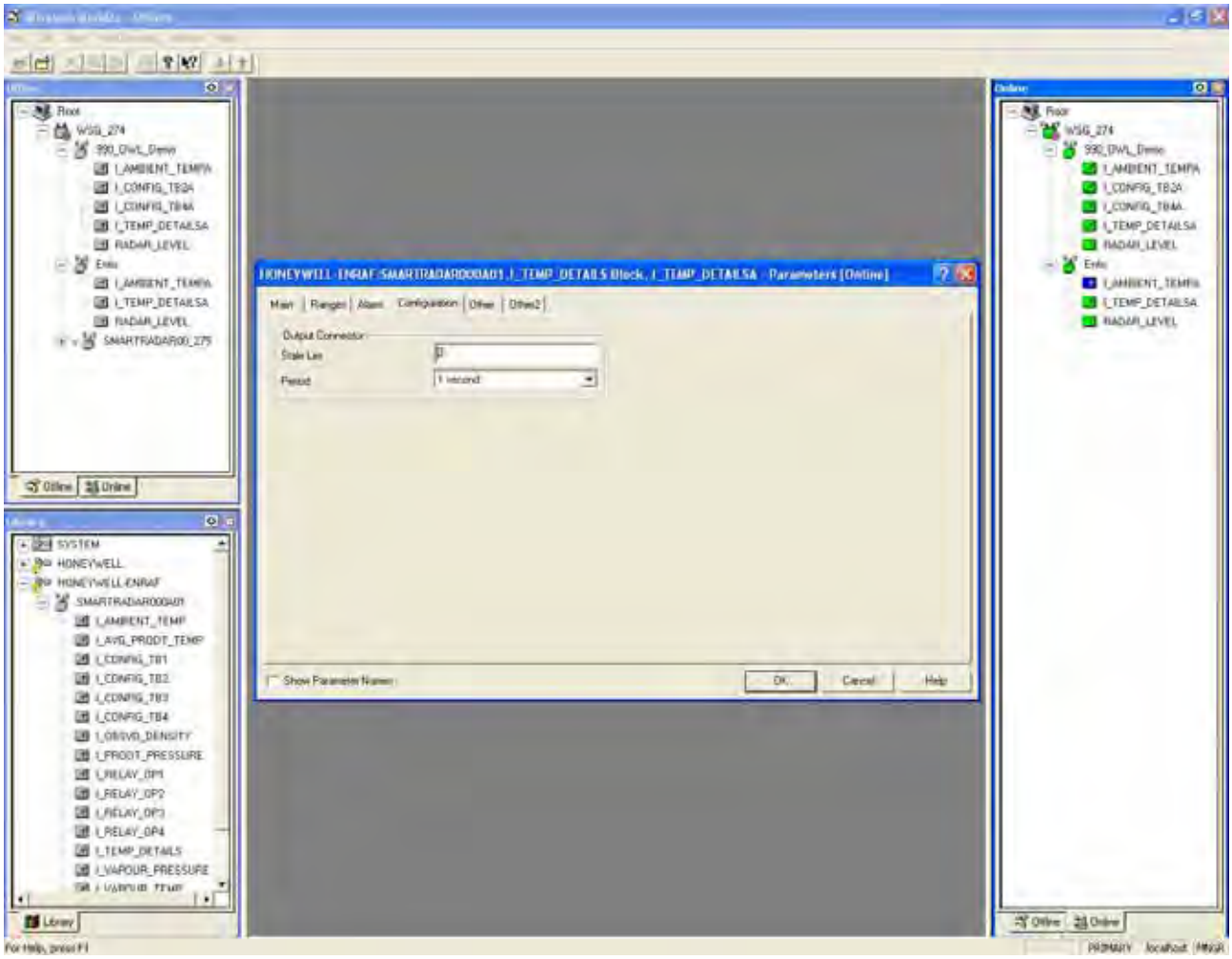
Parameter	Description
Alert Disable	With this settings it is possible to disable an alarm.
Alert Priority	With this setting it is possible to define the alert priority. For more information on alert priority, see the Onewireless Documentation.
In Alarm	This light shows the actual alarm status.
Alarm Limit	This is the alarm trip point.

NOTE: The alarm hysteresis is defined in the “Other” tab.

NOTE: Having alerts on measured variables is not standard in OneWireless. Be careful using these alarms when the user is also using Experion. As these alarms will be visible as system alarms and NOT as process alarms.

6.4.5.2.4.4 Configuration Tab

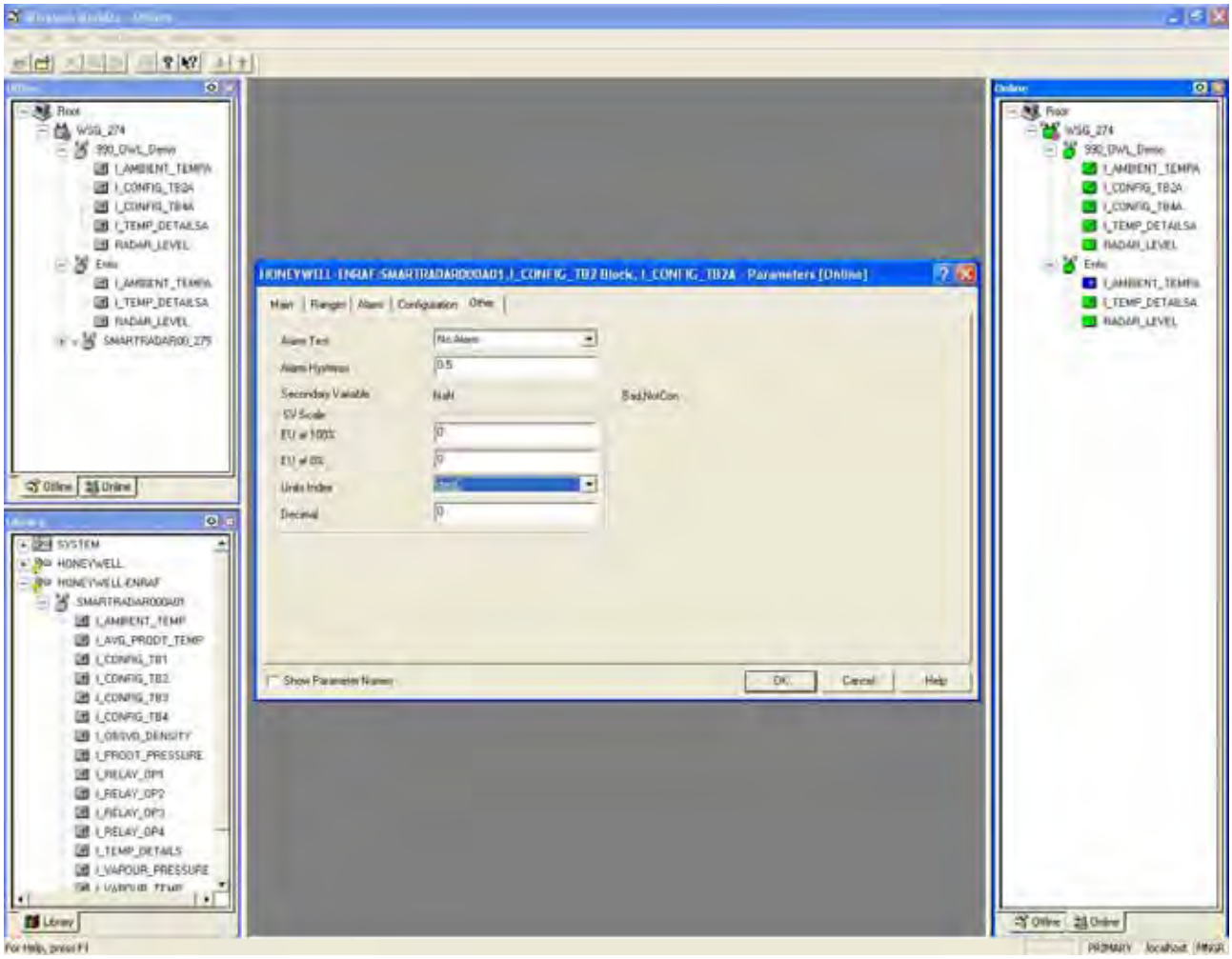
This tab describes the publication time and time-out settings.



Parameter	Description
Stale Lim	Publication data stale limit. For more details, see OneWireless documentation.
Period	This setting determines the publication time for the primary variable of this transducer block. This can be 1, 5, 10, or 30 seconds. For more details, see OneWireless documentation.

6.4.5.2.4.5 Other Tab (1)

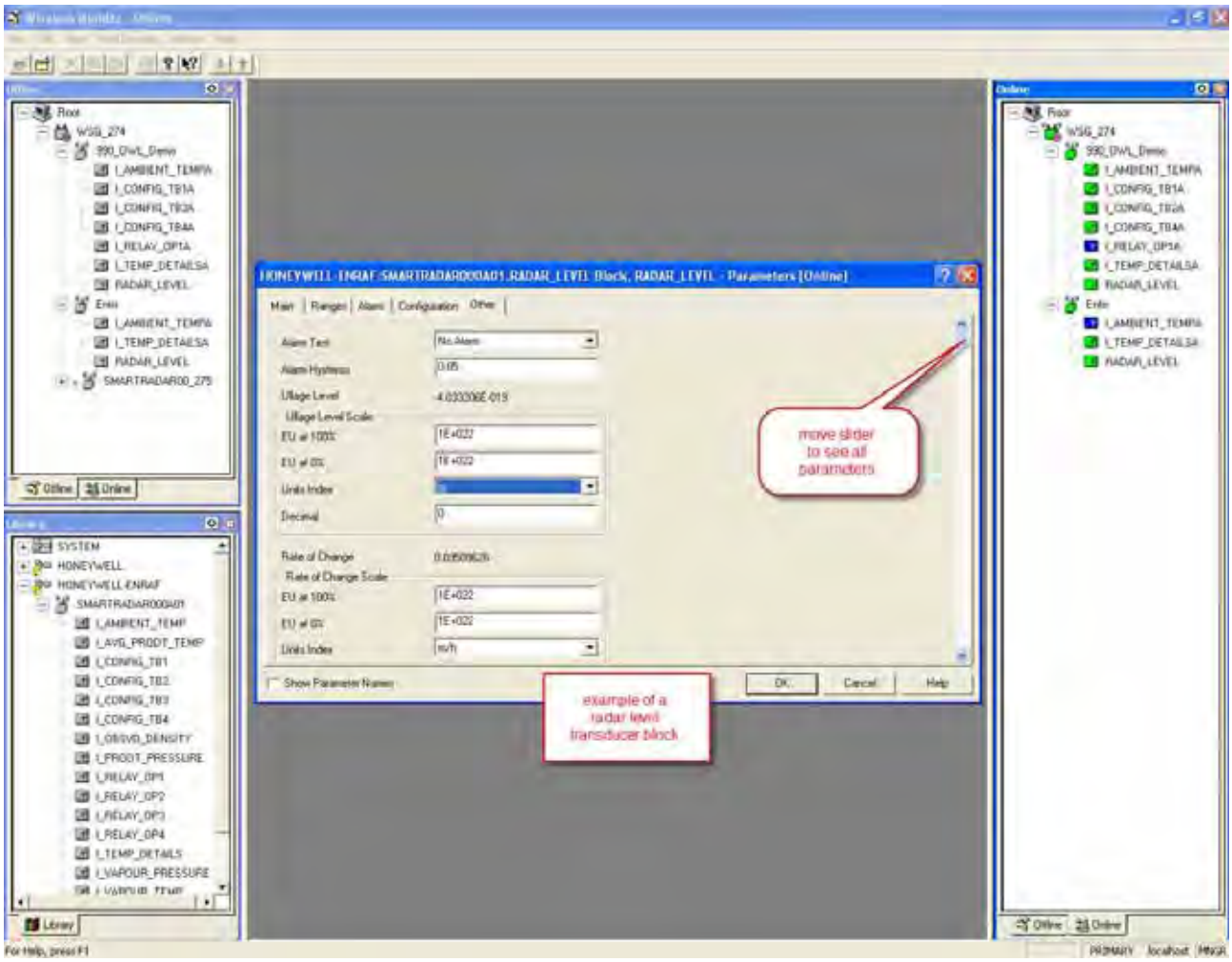
Via this tab, an alarm test can be initiated.



Parameter	Description
Alarm Test	By selecting an alarm level to test - High high, High, Low, or Low low - and pressing OK, the SmartRadar will perform an Alarm test command. For detail settings, see 6.4.5.2.4.6.
Alarm Hysteresis	This is the alarm hysteresis setting. For detail settings, see 6.4.5.2.4.6.

6.4.5.2.4.6 Other Tab (2)

The following example screen shows possible detail settings of the Other tab.



Parameter	Description
Alarm Test	By selecting an alarm level to test - High high, High, Low, or Low low - and pressing OK, the SmartRadar will perform an Alarm test command. For detail settings, see 6.4.5.2.4.6.
Alarm Hysteresis	This is the alarm hysteresis setting. For detail settings, see 6.4.5.2.4.6.
Ullage Level Scale:	
- EU at 100%	Not used in the SmartRadar FlexLine
- EU at 0%	Not used in the SmartRadar FlexLine
- Units Index	In this field you can select the required engineering unit from the list of available units. (level units for the level TB, and temperature units for the temperature TB). Note: For supported units, see 6.4.5.2.8.

Parameter	Description
- Decimal	Not used in the SmartRadar FlexLine
Rate of Change Scale:	
- EU at 100%	Not used in the SmartRadar FlexLine
- EU at 0%	Not used in the SmartRadar FlexLine
- Units Index	In this field you can select the required engineering unit from the list of available units. (level units for the level TB, and temperature units for the temperature TB). Note: For supported units, see 6.4.5.2.8.
- Decimal	Not used in the SmartRadar FlexLine

6.4.5.2.5 Configurable Transducer Block Settings

The *configurable* transducer blocks are special in the way that they do not represent a fixed input function of the SmartRadar. Configurable transducer blocks can be programmed to represent any available functions on any of the available FlexConn boards in the SmartRadar.

*NOTE: The configuration of the configurable transducer blocks must be done **using Engauge**.*

Example

Configurable Transducer block 1 could be programmed to represent the radar level from the CAN-XBAND. Then the PV of this tranducer block will represent the PV of the radar level function, the Innage value. The SV of this transducer block will represent the SV of the radar level function, the Ullage level.

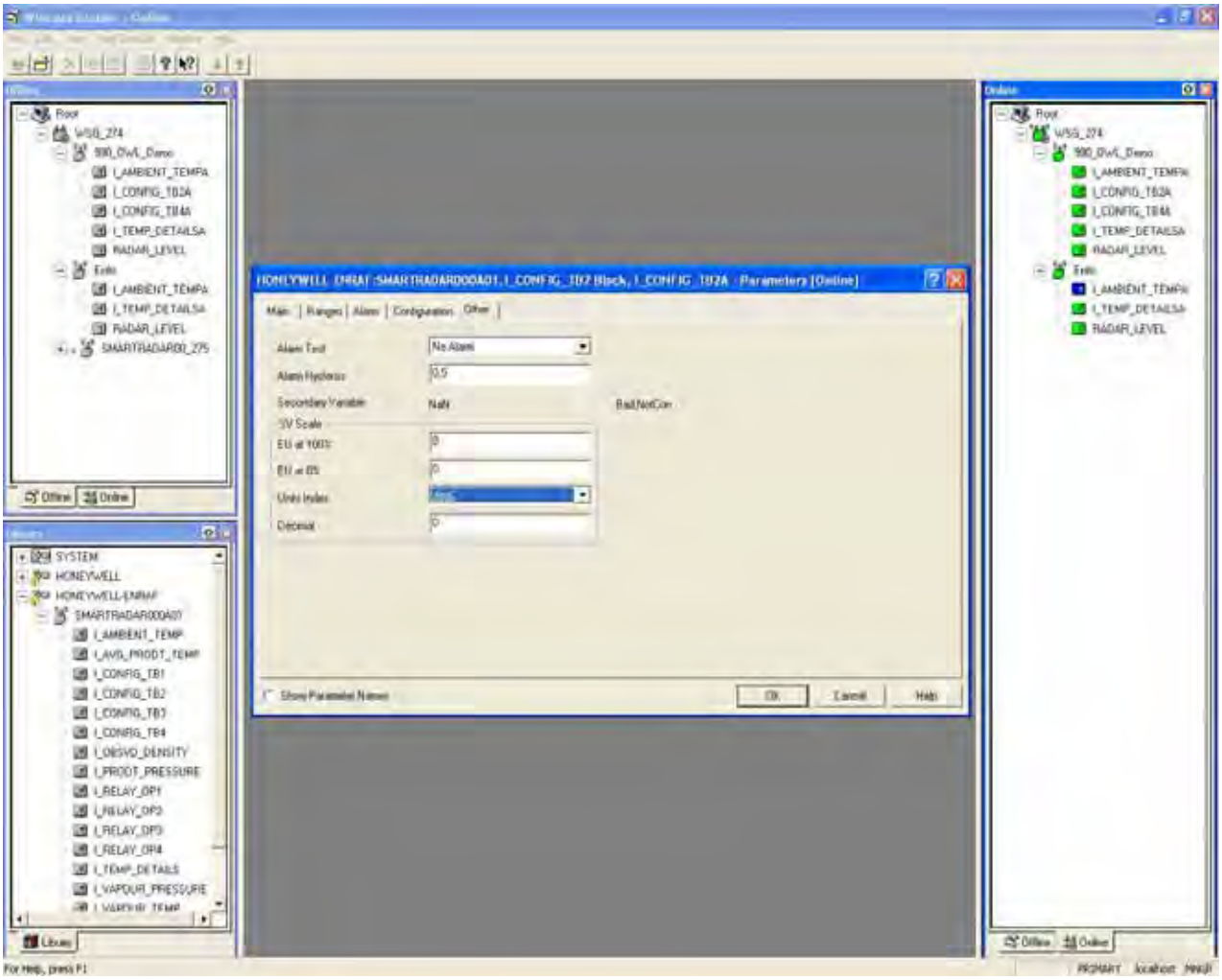
The current firmware version does have *some limitations* on what can be programmed in these transducer blocks.

- Configurable *Transducer block 1* can only represent *Levels*. This is valid for both the PV and the SV.
- Configurable *Transducer block 2* can only represent *Temperatures*. This is valid for both the PV as the SV.
- Configurable *Transducer block 3* can only represent *either pressure or Density*. This is valid for both the PV and the SV.
- Configurable *Transducer block 4* can represent parameters with variable dimensional units. The following parameters are supported: *Level, Temperature, Pressure, Density, Current, or NO UNIT*. This is valid for both the PV and the SV.

In wireless builder these limitations must be taken into account *when changing the units index*, for both the PV as the SV. Selecting a dimensional unit that is not supported by the Transducer block will give an error message.

The *Units Index* for the PV can be found on the *Ranges* tab.

The *Units Index* for the SV can be found on the *Other* tab. This tab has a different layout than in a standard transducer block, and is described hereafter.



Parameter	Description
Alarm Test	By selecting an alarm level to test - High high, High, Low, or Low low - and pressing OK, the SmartRadar will perform an Alarm test command. For detail settings, see 6.4.5.2.4.6.
Alarm Hysteresis	This is the alarm hysteresis setting. For detail settings, see 6.4.5.2.4.6.
Secondary Variable	The secondary variable of this transducer block. This Secondary Variable equals the Secondary Value (SV) of the assigned FlexConn function.
- EU at 100%	Not used in the SmartRadar FlexLine
- EU at 0%	Not used in the SmartRadar FlexLine

Parameter	Description
- Units Index	In this field you can select the required engineering unit from the list of available units. (level units for the level TB, and temperature units for the temperature TB). Note: See also limitations described before. Note: For supported units, see 6.4.5.2.8.
- Decimal	Not used in the SmartRadar FlexLine

6.4.5.2.6 Temperature Details Transducer Block Settings

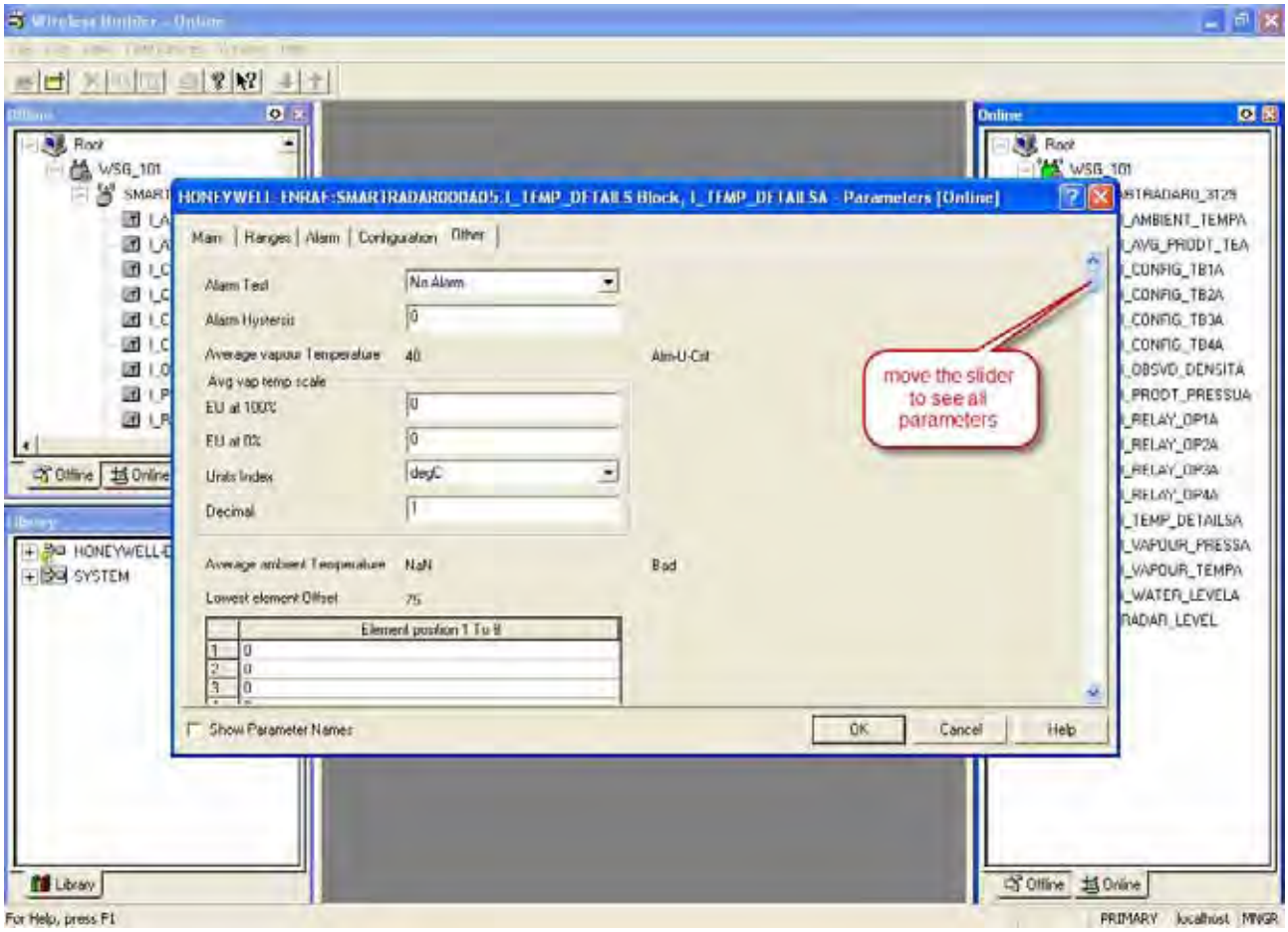
The *Temperature Details transducer block* is an additional temperature transducer block that can be used if details of individual temperature elements (for example, to make a temperature profile) are relevant.

Just like the Average product temperature transducer block, it publishes the average product temperature as PV and the Vapour Temperature as SV.

The additional parameters can be used via Wireless Builder or the OPC server.

NOTE: This Transducer block is not necessary when making temperature profiles via a tool that uses GPU communication.

The temperature details can be found on the *Other* tab that. This tab has a different layout than it has in a standard transducer block. It is described below.



Parameter	Description
Alarm Test	By selecting an alarm level to test - High high, High, Low, or Low low - and pressing OK, the SmartRadar will perform an Alarm test command. For detail settings, see 6.4.5.2.4.6.
Alarm Hysteresis	This is the alarm hysteresis setting. For detail settings, see 6.4.5.2.4.6.
Average Vapour temperature	This is the average vapour temperature
EU at 100% (avg temp scale)	Not used in the SmartRadar FlexLine
EU at 0%	Not used in the SmartRadar FlexLine

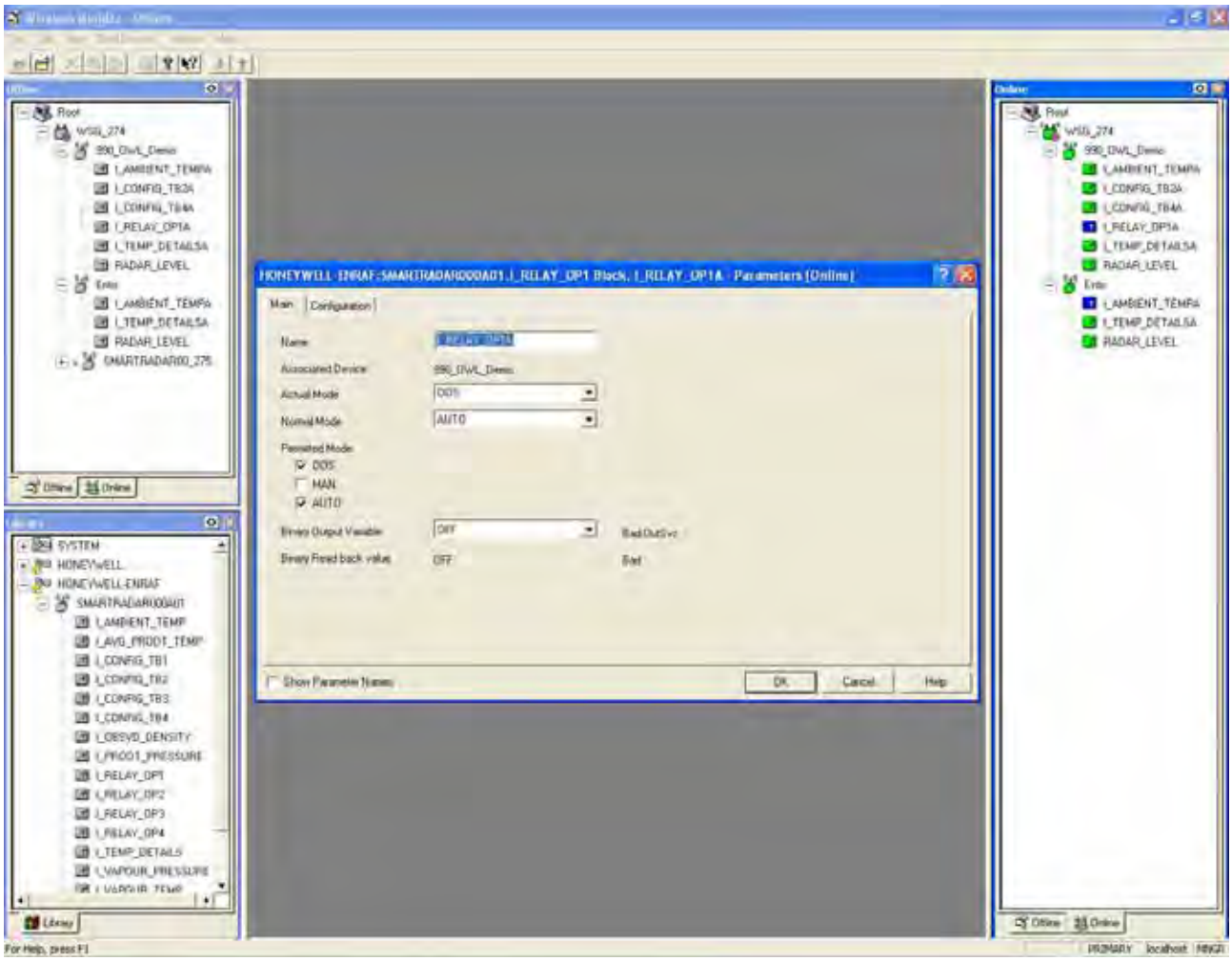
Parameter	Description
Units Index	In this field you can select the required engineering unit from the list of available units. (level units for the level TB, and temperature units for the temperature TB). Note: For supported units, see 6.4.5.2.8.
Decimal	Not used in the SmartRadar FlexLine
Average Ambient temperature	This is the average ambient temperature
Lowest element offset	Offset of lowest temperature element relative to the bottom of the tank
Element position 1...8	Position of the temperature elements 1...8
Element position 9...16	Position of the temperature elements 9...16
EU at 100% (level scale)	Not used in the SmartRadar FlexLine
EU at 0%	Not used in the SmartRadar FlexLine
Units Index	In this field you can select the required engineering unit from the list of available units. (level units for the level TB, and temperature units for the temperature TB). Note: For supported units, see 6.4.5.2.8.
Decimal	Not used in the SmartRadar FlexLine
Element temperature 1...8	Temperature of element 1...8
Element temperature 9...16	Temperature of element 9...16
Element temperature status 1...8	Status of element temperature 1...8
Element temperature status 9...16	Status of element temperature 9...16
Number of elements	Number of installed temperature elements
MRT or RTD element type	Type of installed temperature element TPL = MTT Honeywell Enraf QSA = MRT Sangamo SPL = Spot PT100 Large SPS = Spot PT100 Small SNI = Spot Ni191 SSS = Spot Sangamo CU90 SCB = Spot Beacon CU90 SCN = Spot CU90 Nulectohm

6.4.5.2.7 Relay Output Transducer Block Settings

The *Relay output transducer blocks* are standard *Binary Output* transducer blocks. (In contrast to all other transducer blocks, which are *Analog Input* transducer blocks.)

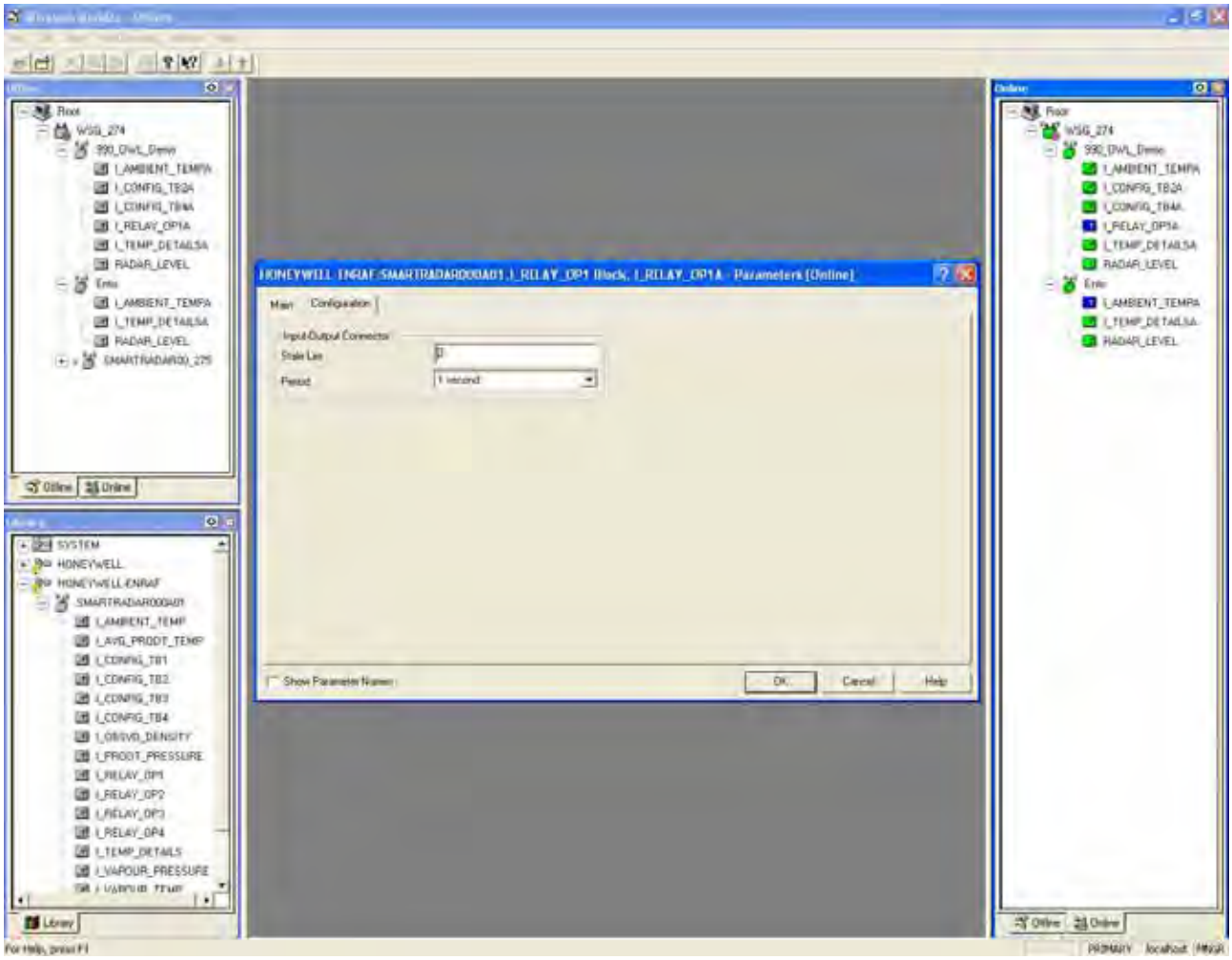
There are 4 relay output blocks, each representing one of the 4 relays that can be installed in the SmartRadar FlexLine. These transducer blocks can be used to remotely control the relays, provided these relays are programmed as remote controllable in Engauge.

For sample screens and parameter descriptions, see below.



Parameter	Description
Name	Here you can specify the name of the transducer block.
Associated Device	The device that contains the transducer block you are editing. The device name is set during commissioning with Wireless Builder and is stored in the TAG descriptor entity.

Parameter	Description
Actual Mode	The actual operation mode of the transducer block. This may differ from the normal mode, for example if the device is Out of Service.
Normal Mode	This is the mode the transducer block should be in, in normal situations.
Permitted Mode	With these check boxes you can select the permitted modes for the transducer block.
Binary Output Variable	This field can be used to control the relay. This field has no function if the relay itself is not programmed to be a remote controlled relay.
Binary Read back value	This is the read-back value that represents the actual position of the relay.



Parameter	Description
Stale Lim	Publication data stale limit. For more details, see OneWireless documentation.
Period	This setting determines the publication time for the primary variable of this transducer block. This can be 1, 5, 10, or 30 seconds. For more details, see OneWireless documentation.

6.4.5.2.8 Supported Units

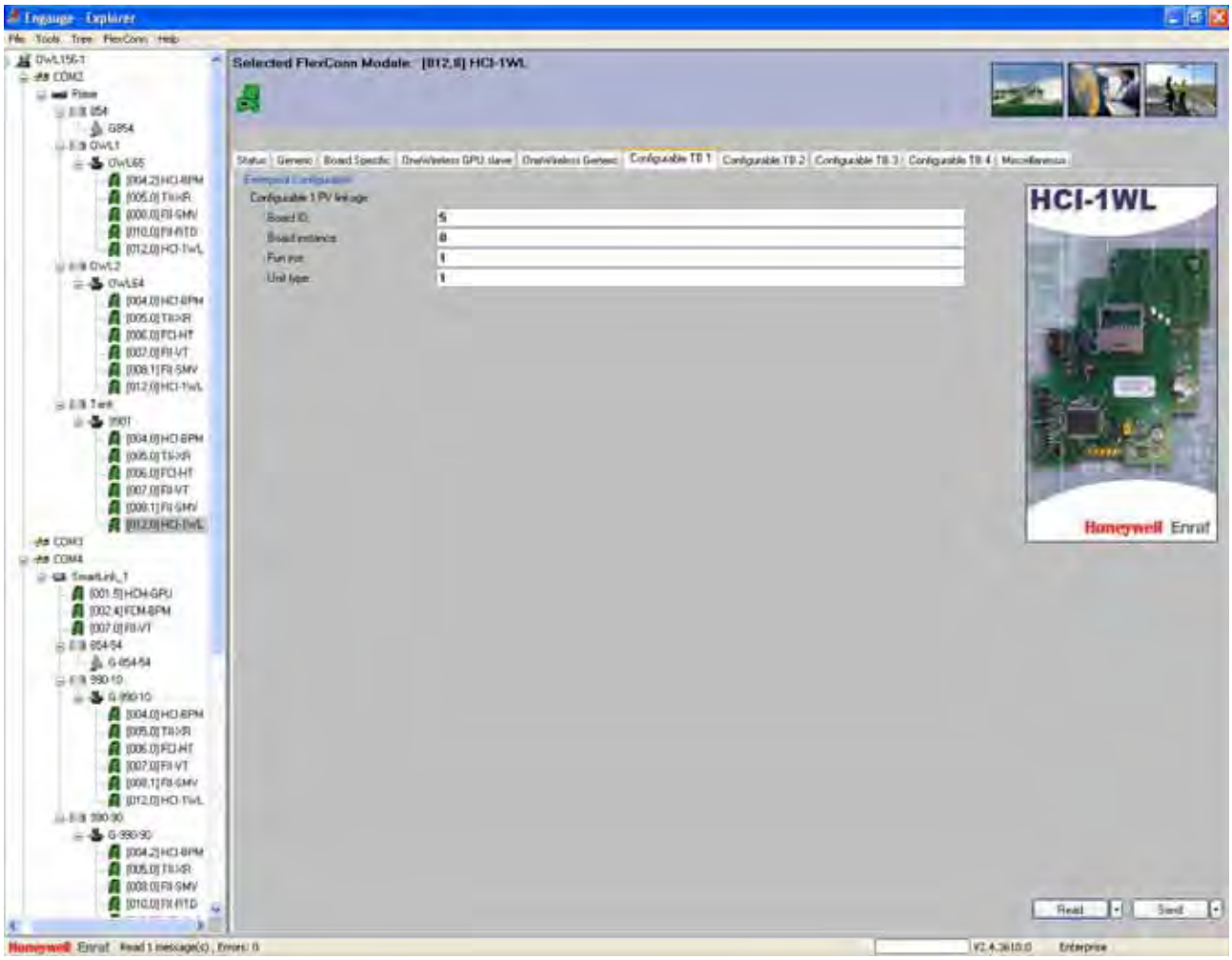
The SmartRadar Flexline supports the following units:

Parameter	Supported Units
Level and position	Meters (m)
	Millimeters (mm)
	Inches (in)
	Feet (ft)
Level rate of change	Millimeters / second (mm/s)
	Meters / hour (m/h)
	Inch / minute (in/min)
	Feet / minute (ft / minute)
Temperature	Degrees Celsius (ºC)
	Degrees Fahrenheit (ºF)
Pressure	Pascal (Pa)
	kilo Pascal (kPa)
	bar
	psi
Density	kg / m^3
	kg / l
	g / ml
	lbs / ft^3
	deg API

6.4.6 Commissioning the HCI-1WL Configurable Transducer Blocks

The configuration of the configurable transducer blocks can *not entirely be done via Wireless Builder*. To configure the configurable transducer blocks, the following entities must be set by using *Engauge*.

NOTE: These settings are only available for Engauge Professional users.



Name	Explanation	Value Range	Default
[Board ID]	The board ID of the board that contains the function you want to map to the configurable transducer block. Look in the board list which boards are available.	<0...255>	<0>
[Board Instance]	The board instance of the board that contains the function you want to map. This is usually 0. Look in the board list to see if any boards are available more than once in the instrument.	<0...7>	<0>

Name	Explanation	Value Range	Default
[Function Instance]	This identifies the function which data you want to map to this transducer block.	<0...15>	<0>
[Unit Type]	The unit type is necessary to identify in One Wireless.	<0...5>	<0> units of data: 0 = no unit 1 = level 2 = temperature 3 = pressure 4 = density 5 = current

All 4 configurable transducer blocks have the same settings in *Engauge*. However the various configurable transducer blocks are reserved for particular types of data:

- *Configurable Transducer block 1* is reserved for *level* data
- *Configurable Transducer block 2* is reserved for *temperature* data
- *Configurable Transducer block 3* is reserved for *density and pressure* data
- *Configurable Transducer block 4* can be used for *any* of the data types mentioned above.

The *Secondary Variable* (SV) of the configurable function block is automatically assigned to the *Secondary Value of the FlexConn board function* that is linked to the Primary Variable PV as described before.

Example

To link a configurable transducer block to the Radar Level of the TII-XR, the following settings need to be configured:

[Board ID] = 5
[Board instance] = 0
[Function instance] = 1
[Unit type] = 1

6.4.7 Commissioning the HCI-1WL for GPU and FlexConn Communication

By using a *protocol tunnel* through the OneWireless network, it is possible to connect the standard Honeywell Enraf Entis systems, or service tools.

The physical connection between the Entis systems or service tools is either via an *Ethernet* connection to the Gateway, or via an *RS-232* line through a *Lantronix RS-to-Ethernet convertor* to the Gateway. See chapter 4.2.1 for details.

For a correct functioning of the HCI-GPU module in an instrument (gauge), the following entities ***can*** be set by using either *Engauge* or *SmartView*.

☛By using the following table, check each entity for correctness.

Name	Value Range	Default Value	Explanation
[Identification]	8 characters e.g. <TANK1234>	<-------->	Name of a tank or instrument
[GPU instrument address]	<0..99>	<0>	The address of this instrument for GPU messages. Note: Each instrument must have a unique GPU address.
[GPU Caching]	<caching off> <GPU B record> <GPU C record> <GPU D record> <GPU L record> <GPU M record>	<caching off>	By switching on caching, the system performance can be greatly improved. Switching caching on for a record means that the OneWireless network will automatically keep an up-to-date copy of this record in the internal cache of the gateway. This copy will be refreshed each second. Any request for this record will NOT be sent to the instrument but *directly be answered from the cache*. Note: Do not use this setting for W&M approved systems.
[FlexConn instrument address]	<0..1899>	<0>	The address of this instrument for FlexConn messages. Note: Each instrument must have a unique FlexConn address.
[Level units]	<meters> <inches> <feet> <fractions>	<meters>	The unit in which level-related GPU records and items are shown
[Temperature units]	<celsius> <fahrenheit>	<celsius>	The unit in which temperature-related GPU records and items are shown

Name	Value Range	Default Value	Explanation
[Pressure units]	<pascal> <kilo pascal> <psi small> (2 digits before separator) <psi large> (3 digits before separator)	<pascal>	The unit in which pressure-related GPU records and items are shown
[Density units]	<kilogram m3> <degrees API> <pounds ft3>	<kilogram m3>	The unit in which density-related GPU records and items are shown
[Decimal separator]	<point> <comma>	<point>	The decimal separator in which GPU-related records and items are shown
[Level type]	<innage> <ullage>	<innage>	The level-related GPU records and items can be shown as an innage or ullage. Note: • *Innage* is the level of the product measured from the bottom. • *Ullage* is the level of free space from the roof till the product.
[Password]	<.....> 6 characters	<ENRAF2>	Password for entering the protected level. Note: Some settings reside under the protected level.
[Function identification]	<.....> 13 characters	<GPU-slave>	The name of the current function of this module. This name is visible on the *SmartView* display.

☛After having checked/set all before listed entities, make sure

- the [Board Commissioned] and the [OneWireless GPU slave Commissioned] entities are <True>;

the [Board Health] and the [OneWireless GPU slave Health] entities are <GOOD>.

6.4.8 Using the SmartView with the OneWireless Communication Option

6.4.8.1 Introduction

The *SmartView* replaces the display that is usually available on OneWireless transmitters.

6.4.8.2 SmartView OneWireless Status Display

At the *Smartview*, there is a special OneWireless status display available, called the [extra information] display. See screen below.

Parameter	Description
PRSSI	Primary RSSI = Signal strength indicator for primary wireless connection
SRSSI	Secondary RSSI = Signal strength indicator for the redundant wireless connection
Connection status	Radio connection status
SD Status	SD-memory card status

This screen is required during commissioning for the authentication process and to check the wireless connection quality. It can also be used in case of wireless connection problems.

☛ At the Smartview, enter the menu by pressing Λ + V simultaneously.

☛ Scroll to the menu item [extra information], and press < + > simultaneously, to enter the OneWireless screen.

NOTE: Since this [extra information] screen is also used for other purposes, it may be possible that you have to configure the 990 SmartRadar to show this screen when the [extra information] menu item is selected. This can be done on the SmartView itself or by using Engauge, see 6.7.2.

- Signal strength (RSSI = Radio Signal Strength Indicator)

The signal strength is shown in dBm. Below -80 to -85 dBm no reliable connection is possible.

When there is no redundant wireless connection the secondary RSSI does not show a relevant value.

- Connection status

In the display of the Smartview the following Connection status messages can / will be visible:

Display Text	Description
NO KEY:	No security key information available Insert a memory card with security information.
MACCONN	Intermediate message during connection process
SECCONN	
CONNECT	The device is connected to the OneWireless network via 2 multinodes / gateways.
DISCOVR	Intermediate message during connection process
NOTCONN	The radio is not connected. Make sure the OneWireless network is operational. Could also happen if the radar is moved to another network.
SECURNG	Intermediate message during connection process
NOREDUN	The device is connected to the OneWireless network via 1 multinode / gateway only.
BAD KEY	No valid key available. Could happen if the radar is moved to another network (e.g. from factory to customer/ from workshop to real-life network etcetera).

- SD Status

In the display of the SmartView one out of the following SD card statuses will be visible:

Display Text	Description
SDOK	SD card with security key present
NOSD	No security key / No SD card / Bad SD card

6.4.9 Radio Board Diagnostic Information and Commands

6.4.9.1 Introduction

Diagnostic information, such as the data in the [extra information] screen, and more, can also be read using *Engauge* (professional version), or with the [Commissioning] screen of the *SmartView*.

Additionally, there are 3 commands that can be given to the radio board on the HCI-1WL module.

6.4.9.2 Commands

☛Select [Read device information], to read the *static* information from the radio board.

After executing this command, the static information from the radio board is read from the radio board and made available in diagnostic entities. See 6.4.9.3.

☛Select [Read dynamic info], to read the *dynamic* information from the radio board.

After executing this command, the dynamic information from the radio board is read from the radio board and made available in diagnostic entities. See 6.4.9.3.

☛Select [Restore Defaults], *to remove the security key information* from the radar.

In this way, the radar is disconnect from the wireless network.

NOTE: This command CANNOT be given via Engauge.

CAUTION! With this command all settings on the radio board will be erased!

6.4.9.3 Diagnostic Information

- SD Card Status

Display Text	Description
SDOK	SD card with security key present
NOSD	No security key / No SD card / Bad SD card

- Connection Status

Display Text	Description
NO KEY:	No security key information available Insert a memory card with security information.
MACCONN	Intermediate message during connection process
SECCONN	
CONNECT	The device is connected to the OneWireless network via 2 multinodes / gateways.
DISCOVR	Intermediate message during connection process
NOTCONN	The radio is not connected. Make sure the OneWireless network is operational. Could also happen if the radar is moved to another network.
SECURNG	Intermediate message during connection process
NOREDUN	The device is connected to the OneWireless network via 1 multinode / gateway only.
BAD KEY	No valid key available. Could happen if the radar is moved to another network (e.g. from factory to customer/ from workshop to real-life network etcetera).

- Radio Signal Status

Parameter	Description
TX power level	Transmission power level Note: This is an Advanced Setting! Please read section 6.4.10 before changing this setting.
PRSSI	Primary RSSI = Signal strength indicator for primary wireless connection
SRSSI	Secondary RSSI = Signal strength indicator for the redundant wireless connection

- Additional Items

Parameter	Description
Radio diagnostic	No explanation. These diagnostic information items are only relevant if requested by the factory.
Radio software build number	
Radio Network address	
Radio communication channel	
Wireless Network ID	
Radio mode	
Radio IEEE Address	

6.4.10 Advanced Settings - Transmission Power Level

Professional installers are allowed to change to power settings in situations that an *external antenna* is used to compensate for long external cables.

CAUTION! It is NOT allowed to set the transmission power to a higher level than is allowed by the local authorities. When a radar with an integrated antenna is ordered, the value is set to the correct value in the factory.

CAUTION! Only when an external antenna is used, it is allowed to change this setting and only according to the table below.

- For transmission power-level settings, see table below.

Area	Antenna Type	Integrated	Remote Cable lenght 1 m	Remote Cable length 3 m	Remote Cable length 10 m
		Maximum transmission power level setting			
Europe	4 dBi	9	10	10	12
	8 dBi	4	5	6	7
	14 dBi	Not possible	1	1	2
USA and Canada	All types	20			

*CAUTION! For the remote antenna cables **only the cables provided by Honeywell Enraf** are approved for use. The use of any other cables or cable lengths are NOT allowed by the Radio approvals.*

- The values in the above tables have been determined through agency certification testing.
- The above output-power levels include the loss from the Lightning Arrestor (0.5dBm).

CAUTION! Lightning arrestor must be in place for all installations.

- The following shall apply for antenna type, frequency range, application/usage, and agency/country compliance:
  - Antennas with a higher gain as shown above shall not be used.
  - Maximum overall radio output power shall not exceed 10 mW EIRP (Europe) respectively 100 mW EIRP (USA and Canada) over the full band.
- Industry Canada Compliance Statement:
  - This device has been designed to operate with the antenna types listed in this document, and having a maximum gain of 14 dBi. Antenna types not included in this list or having a gain greater than 14 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.
  - This device complies with Part 15 of the FCC rules **and RSS-210 of IC**.

6.4.11 Firmware Upgrade

You can upgrade the radio firmware via OneWireless *Wireless Builder*.

For more details see the Wireless Builder manual in the chapter *"Upgrading Firmware in commissioned device"*.

*NOTE: Only the **radio firmware** can be upgraded via Wireless Builder. Firmware upgrade of the HCI-1WL board and the other FlexConn boards is done via the normal FlexConn upgrade procedures.*

6.5 Product Level Measurement (TII-XR)

6.5.1 Introduction

The Transducer Interface Instrument - X-Band Radar (TII-XR) - is the heart of Enraf's precision X-band (10 GHz) radar system.

It uses the Frequency Modulated Continuous Wave (FMCW) and synthesized pulse reflection principle. Using Enhanced Performance Signal processing (EPS), a smart level detection is possible by filtering out known obstacles.

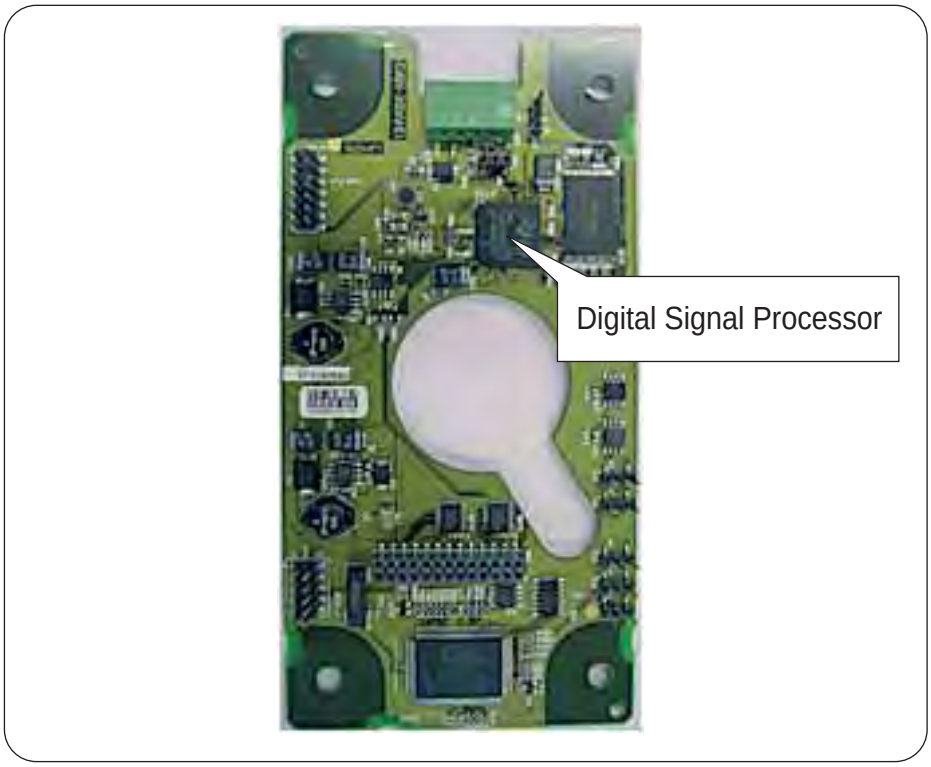


FIGURE 6-6 The TII-XR board with its Digital Signal Processor ESF07-0007

Housed within an explosion-proof, RF-shielded compartment - which also contains a number of other FlexLine modules - and together with a planar radar antenna, it forms the SmartRadar FlexLine system.

6.5.2 Basic Commissioning

6.5.2.1 General

In general the user is interested in the tank's product *volume*. To calculate this volume, the primary input is the product *level* within the tank. This level is measured by the radar.

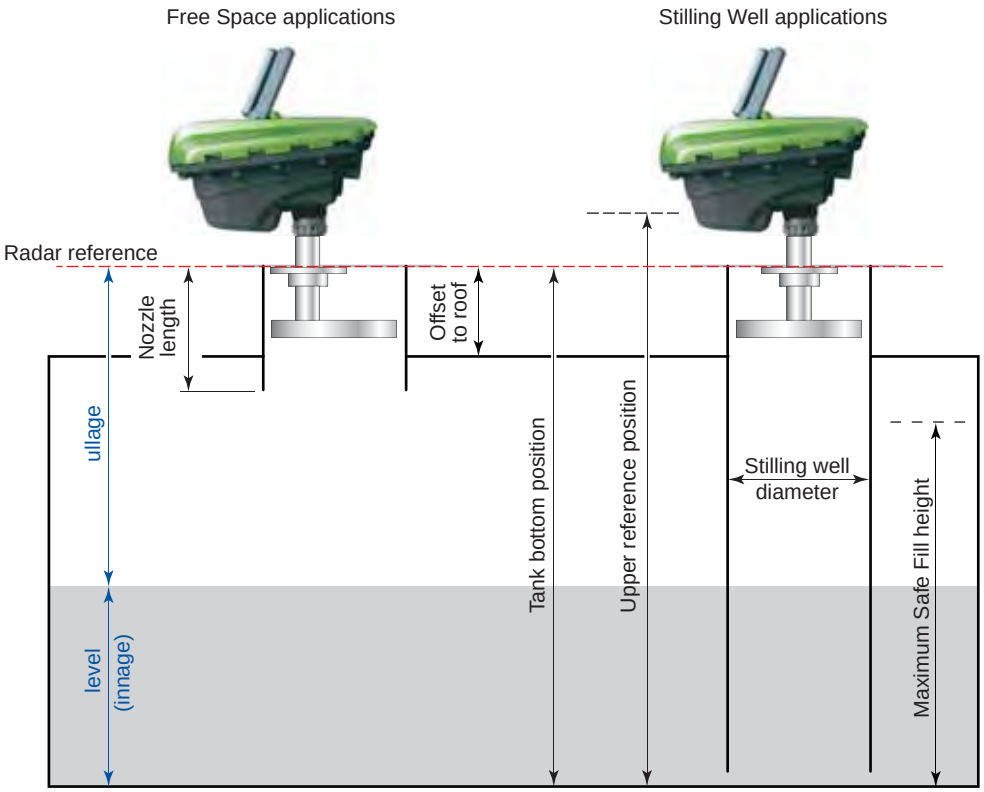
For correct measuring results, a number of parameters such as [Tank bottom position], [Upper reference position], and [Offset to roof] must be defined before.

In addition, alarm settings and compensation (filtering) constants are to be set.

This can be done by using either *Engauge* or *SmartView*.

6.5.2.2 Level Start-Up

For entity definitions, see FIGURE 6-7 and FIGURE 6-8.



ESF07-0008

FIGURE 6-7 Basic commissioning entities

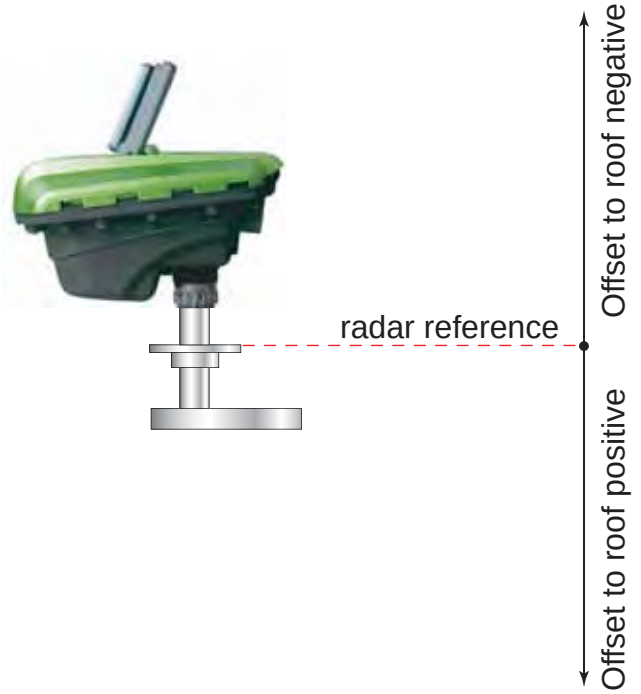


FIGURE 6-8 Definition of [Offset to roof] ESF07-0011

Engauge SmartView

☛To get the radar gauge level without any compensations enabled (but with averaging filter and maximum Safe fill warnings enabled), program the entities listed in the tables below.

☛For a *Free space* application, program following entities:

Entity Name	Explanation
[Tank bottom position]	The gauge uses this information to calculate the level (innage), and to determine the position of the bottom reflection (part of peak selection).
[Maximum Safe fill]	With this entity the gauge checks if the programmed upper measuring range is valid ([Minimum measurable distance] at least <0.5 m> from the antenna).
[Upper reference position]	This entity is only used if “ullage” is to be read from the SmartRadar FlexLine. The ullage is then calculated from the measured level (innage) as [Upper reference position]-measured level.
[Offset to roof]	The distance between radar reference and the tank roof. The gauge uses this information to determine the position of the echoes caused by the product and the roof. A positive value means the roof is below radar reference (see also FIGURE 6-8).

Entity Name	Explanation
[Nozzle length]	Needs only to be set if the antenna is installed inside the nozzle.

☛For a *Stilling well* application, program following entities:

Entity Name	Explanation
[Tank bottom position]	The gauge uses this information to calculate the level (innage), and to determine the position of the bottom reflection (part of peak selection).
[Maximum Safe fill]	With this entity the gauge checks if the programmed upper measuring range is valid ([Minimum measurable distance] at least <0.5 m> from the antenna).
[Upper reference position]	This entity is only used if “ullage” is to be read from the SmartRadar FlexLine. The ullage is then calculated from the measured level (innage) as [Upper reference position]-measured level.
[Stilling well diameter]	The inner diameter of the stilling well

6.5.2.3 Level Check

With the [Accept reference] command, the gauge’s innage or ullage value is initialized in accordance with the before programmed reference data. From here the gauge will follow all relative level changes.

This command will only be accepted if the product level is <GOOD>.

This command also puts the SmartRadar FlexLine in accurate level measurement mode, so this command MUST be given!

The [Accept reference] command can handle either a reference *innage* or a reference *ullage* level. To adjust to an innage level fill in entity [Reference innage], to adjust to an ullage level fill in entity [Reference ullage]. This level value is mostly obtained by a manual level measurement (hand dip); see FIGURE 6-9.

When all values are sent to the SmartRadar FlexLine, the [Accept reference] command can be given.

When an innage or ullage reference value is not available, the [Accept reference] command must be given without filling any of these entities. The SmartRadar FlexLine will now be put into accurate level measurement mode.

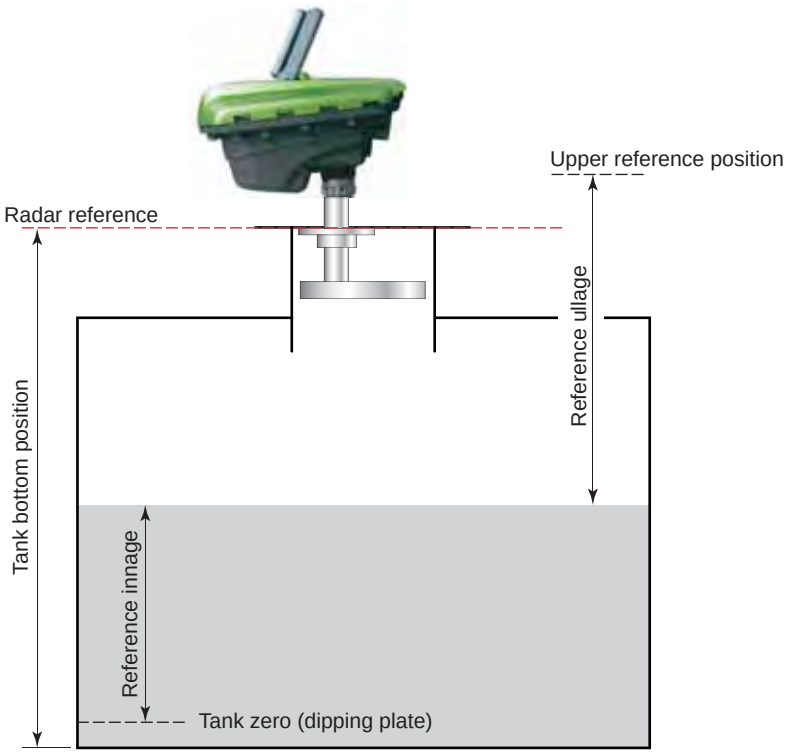


FIGURE 6-9 Level check entities

ESF07-0009

NOTE: This command does not adjust the [Tank bottom position], so this entity should be set manually to approximately the correct value (within ± 0.1 m).

Engauge
SmartView

☛ Give the [Accept reference] command.

☛ Make sure the [Accept reference status] is <GOOD>.

Some remarks for the *Engauge* users:

- To make sure the [Accept reference] command works fine, all entities must have been sent to the gauge (no yellow backgrounds may be visible) prior to giving the command.

☛ To read the [Accept reference status], push the [Read] button (is *not* automatically displayed).

Some remarks for the *SmartView* users:

- On the *SmartView* display, the advanced entity [Reference radar] is visible as well. The value of this entity must be left to the default value <+999.9999>.

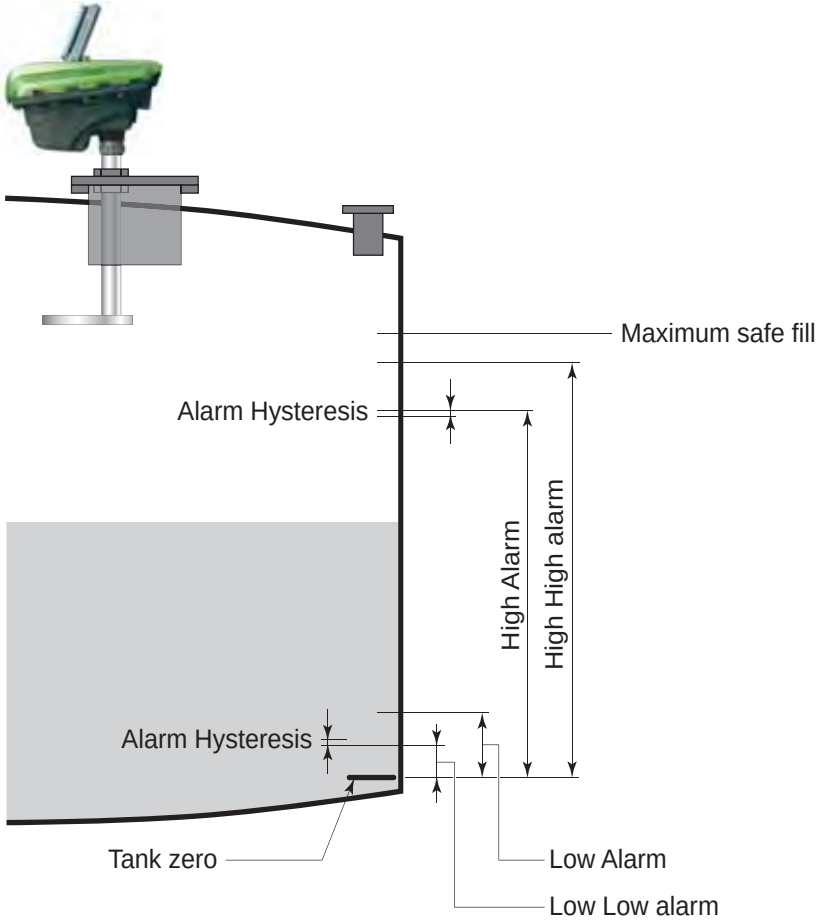
☛ Check [Reference status] in the commissioning menu, to see if the command has been accepted.

6.5.2.4 Alarm Settings

Engauge SmartView

☛Set the entities [High high alarm], [High alarm], [Low alarm], [Low low alarm], and [Alarm hysteresis] to the desired values.

For definitions, see FIGURE 6-10



ESF07-0012

FIGURE 6-10 Alarm and hysteresis definitions

Attention!

- All above mentioned entities MUST be set as the defaults are extremes (1E+12). If they are not, no errors will be displayed, but the [Commissioned] entity will be <False>.
- If the alarm entities are correctly set, but the [Alarm hysteresis] is not, then any alarms that would raise will never be set off! So watch the [Commissioned] status.
- Be aware that the alarm status is only visible in the [Primary value] entity (*innage*)! It is *not* visible in the [Secondary value] entity (ullage).
- Although the GPU-protocol always contains the alarm status, the current software only passes the actual alarm status to this protocol if the gauge is set to *innage* control. So when ullage status is asked for by the GPU-protocol, NO alarm statuses are displayed.
  Workaround solution: Set the GPU records to *innage*.

6.5.2.5 Alarm Loop Checking

Normally, level alarms can be verified when the level reaches the low-level or high-level alarm set point. The level alarms and, if applicable, the hard alarm contact coupled to one of the level alarms can be checked by a “loop check” command. This check is independent from the actual level value.

The level alarm signalling can be checked in several ways:

- via the communication line to the host
- via the hard alarm output contact

Engauge SmartView

☛To perform the alarm test, set [Alarm test enable] to <Enable> and set [Alarm test] to the required alarm (<High High alarm>, <High Alarm>, <Low Alarm>, or <Low Low alarm>). [Alarm test] is a parameter command, and the command will be executed when the parameter is sent to the gauge. When the command is given, the corresponding alarm will be set for 1 minute.

6.5.2.6 Compensations

6.5.2.6.1 Filtering

The gauge contains an output filter for both radar innage and radar ullage. The higher the [Filter averaging constant], the more damping on the radar innage and radar ullage values. The filter also introduces a lag between actual ullage/innage and filtered ullage/innage when the product level is changing. The higher the [Filter averaging constant], the larger the lag. The minimum [Filter averaging constant] value is 0 (no filtering), the maximum [Filter averaging constant] value is 99. For the general filter behavior, see FIGURE 6-11.

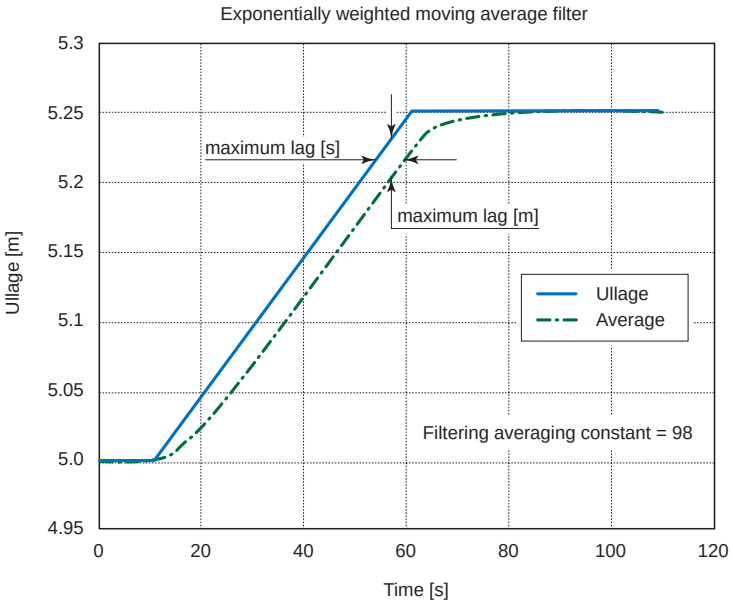


FIGURE 6-11 Filtering characteristic example (level change = 5 mm/s)

In the table below some filtering figures are given.

[Filter averaging constant]	Approximate noise reduction factor	Maximum lag [s]	Maximum lag [distance]
50	1.4	0.1	0.1 * dL/s
70	1.8	0.25	0.25 * dL/s
90	3	1	1 * dL/s
95	4.5	2	2 * dL/s
98	7	5.5	5.5 * dL/s
99	10	11	11 * dL/s

6.5.2.6.2 Verification Pins

When a radar level gauge is installed on a pressurized tank, both ISO and API suggest to use so-called verification pins to verify the radar level measurement. Prime reason to use said verification pins is the impossibility of doing a manual reference dip. With verification pins it is possible to verify the correct reading of the radar measurement at specific heights while the tank is in operation.

The SmartRadar FlexLine can be switched to measure the pin positions. The reading can then be compared with the known position of the pins. It is advised to have three verification pins:

- Pin 1 at approximately 80 - 90 % of tank height
- Pin 2 at approximately 50 % of tank height
- Pin 3 at approximately 10 - 20 % of tank height

Pin 1 should be above maximum safe fill (so, it can always be measured), however there must be at least 0.6 m (2') free space from pin 1 to cone end. All pin positions should be measured with 1 mm (1/32”) uncertainty with reference to the ball valve.

The SmartRadar FlexLine can measure the position of the three pins when the housing is rotated 90°. The verification pins are then ‘visible’ to the SmartRadar FlexLine.
This can be done without closing the 1" (or 4") ball valve, as the FlexLine housing is located above the tank separator.
After the command “Measure verification pins” is given, the measured positions of the three pins can be requested. The “real” position of the pins (from tank drawing) and the “measured” position of the pins are compared and a correction is applied.
After the SmartRadar FlexLine is placed in the normal (product measuring) mode, the measurement is automatically corrected for the found verification pin positions.

FIGURE 6-12 illustrates the correction method for verification pins.
Once the position of the verification pins is determined, the FlexLine can be switched into verification mode to verify the measured (and

corrected) distances with the real pin positions.
If the correction is properly made, both values of each of the three pins should be equal to each other.

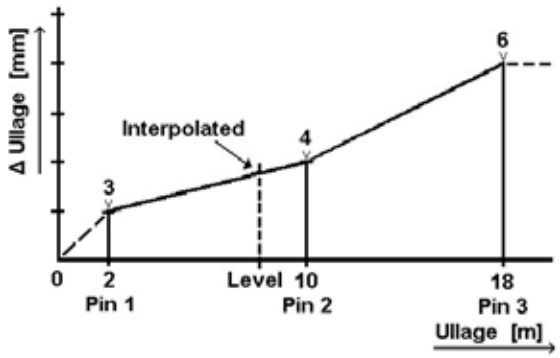


FIGURE 6-12 Ullage correction using the verification pins

If the product level in the tank is above pin position 1 or below pin position 3, the correction is extended by the following estimation:

- above pin1: there is an interpolation from the radar zero point (no correction) to the position of pin 1 (with its correction).
- below pin 3: the correction found at pin 3 is valid for the range below pin position 3.

At installation of the verification pins, the distances of the pins towards the flange of the stilling well (L1, L2, and L3) are noted.

The FlexLine measures ullage from the radar zero point.

NOTE: The radar zero point from the FlexLine with an H04 Antenna is located at the flange of the tank separator. See FIGURE 6-13.

In case the 1" ball valve is used (that is with antenna models H04/N1 and H04/N4), an offset must be added to the distances of the verification pins.

Engauge SmartView

☛The above found verification pin distances must be entered in the following entities:

Entity name	Explanation
Verification pin physical position 1	Physical ullage of verification pin 1 with respect to radar zero
Verification pin physical position 2	Physical ullage of verification pin 2 with respect to radar zero
Verification pin physical position 3	Physical ullage of verification pin 3 with respect to radar zero

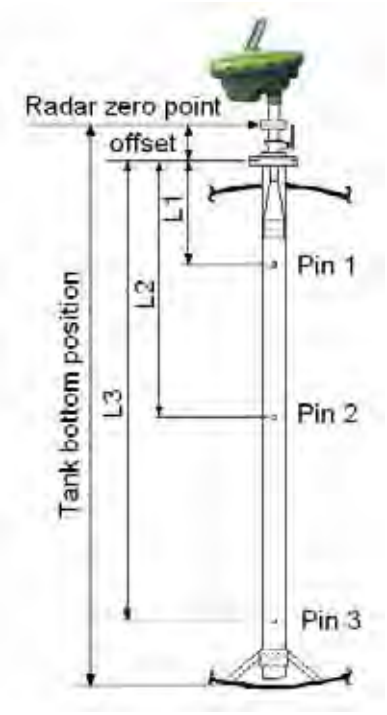


FIGURE 6-13 Radar zero point and verification pins positions

In normal (product measuring) position (see FIGURE 6-14), the E-field (electrical field of the microwave) is located perpendicular to the direction of the verification pins. In this position, the verification pins are less visible to the SmartRadar FlexLine.

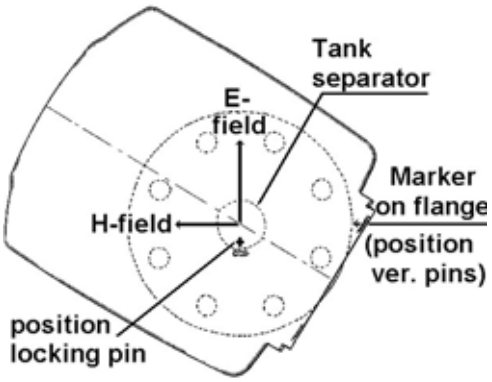


FIGURE 6-14 Product measuring position

In verification pin measuring position (see FIGURE 6-15), the E-field should be in parallel with the verification pin direction. Then the

reflections from the verification pins are stronger and recognized by the SmartRadar FlexLine.

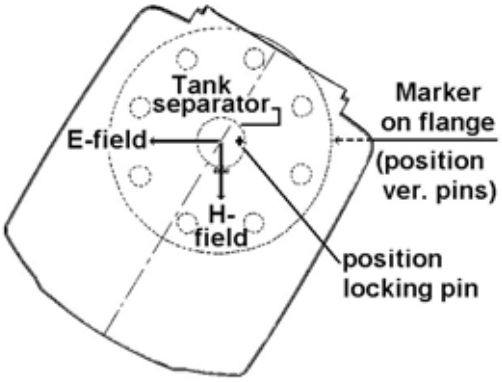


FIGURE 6-15 Verification pin measuring position

To measure the position of the verification pins, the SmartRadar FlexLine must be turned 90 degrees as follows:

- Release the coupling nut of the SmartRadar FlexLine housing.
- Lift the SmartRadar FlexLine housing from tank separator.
- Rotate the SmartRadar FlexLine for 90°. This can only be done in one direction because of the locking pin.
- Place SmartRadar FlexLine on tank separator; mind locking pin.
- Secure the coupling nut of the SmartRadar FlexLine housing.

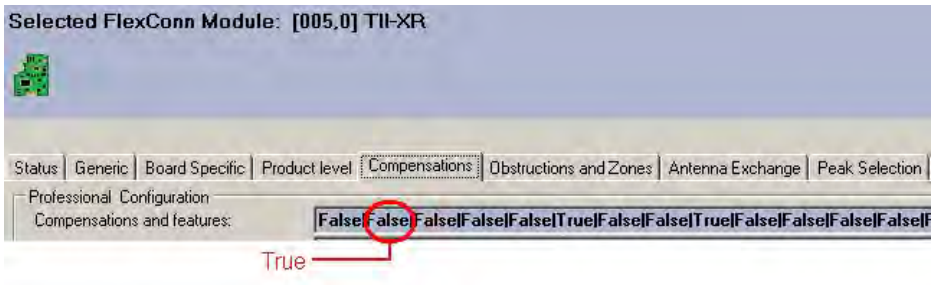
Then issue the command: [Measure verification pins] (on *SmartView*: Calibrate v-pins).

When the verification pin measurement is completed, the SmartRadar FlexLine housing must be turned back 90° (follow above procedure in reverse order).

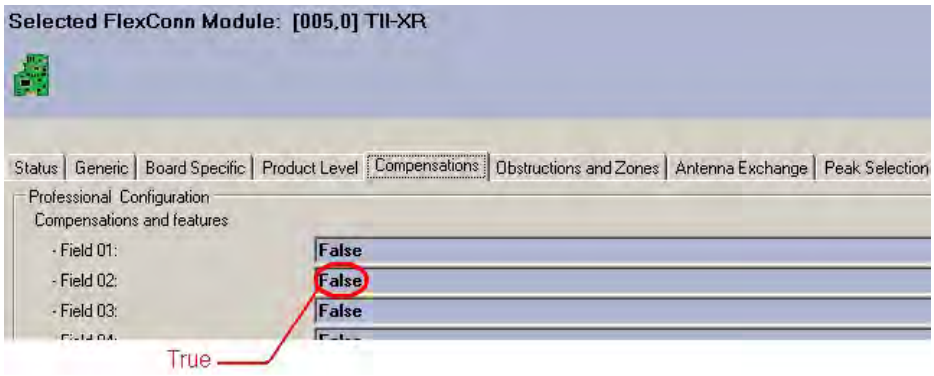
Engauge
SmartView

The verification-pin compensation must be **enabled** by the appropriate switch. In Engauge, that is (depending on installed TII-XR firmware and board descriptor):

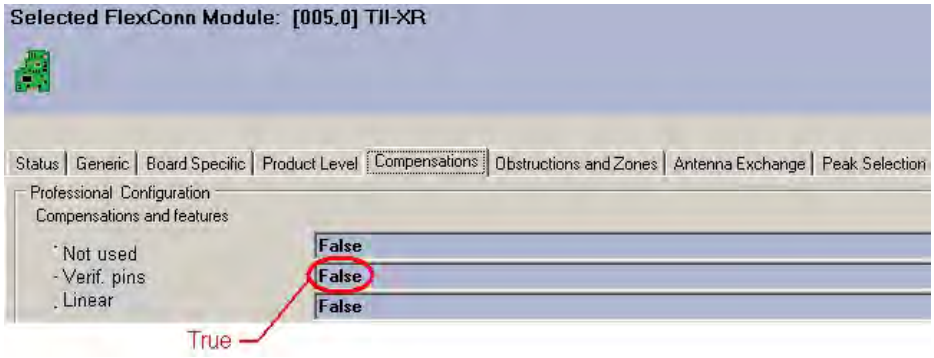
- the second position of correction field:
  (up to TII-XR firmware version A1130 and board descriptor V4)



- or, Field02:
  (with TII-XR firmware version A1131 and board descriptor V5)



- or, Verification pins:
  (from TII-XR firmware version A1140 and board descriptor V6)



Engauge / SmartView

For the *SmartView* the command is implemented from TII-XR firmware version A1142, and resides under the Command menu as follows:

☛From the menu select:

- [Commands]
- board [TII-XR] and
- [Product level].

☛Then scroll through the list of commands, and select the command [Enable v-pins].

To **disable** the verification pin compensation, proceed as follows:

Engauge / SmartView

- By *Engauge*:

☛Set the appropriate field in the Compensation TAB to <False>.

- By *SmartView*:

☛From the menu select:

- [Commands]
- board [TII-XR] and

■ [Product level].

☛Then scroll through the list of commands, and select the command [Disable v-pins].

Below an example of two *reflection diagrams* from product measuring mode and verification-pin measuring mode, and an example of the *compensation sheet*.

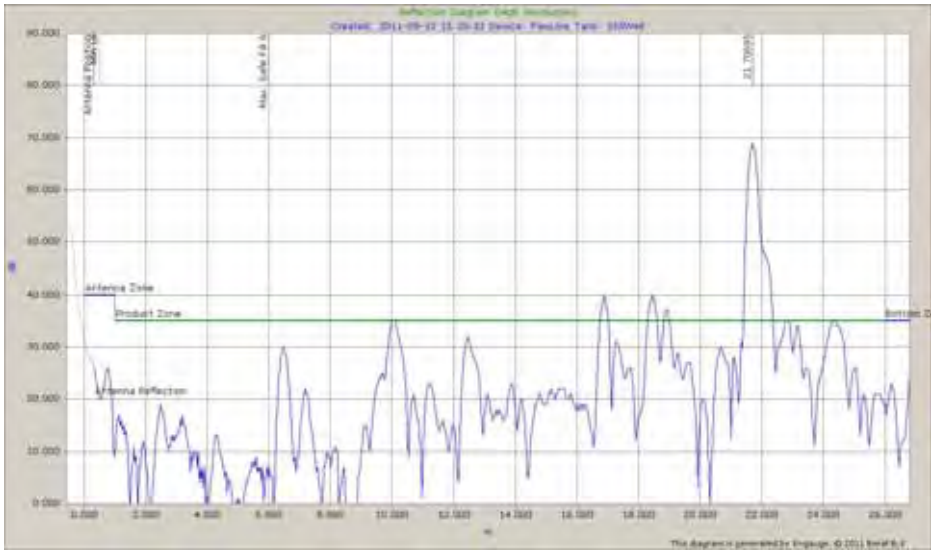


FIGURE 6-16 Product measuring mode, reflection diagram example

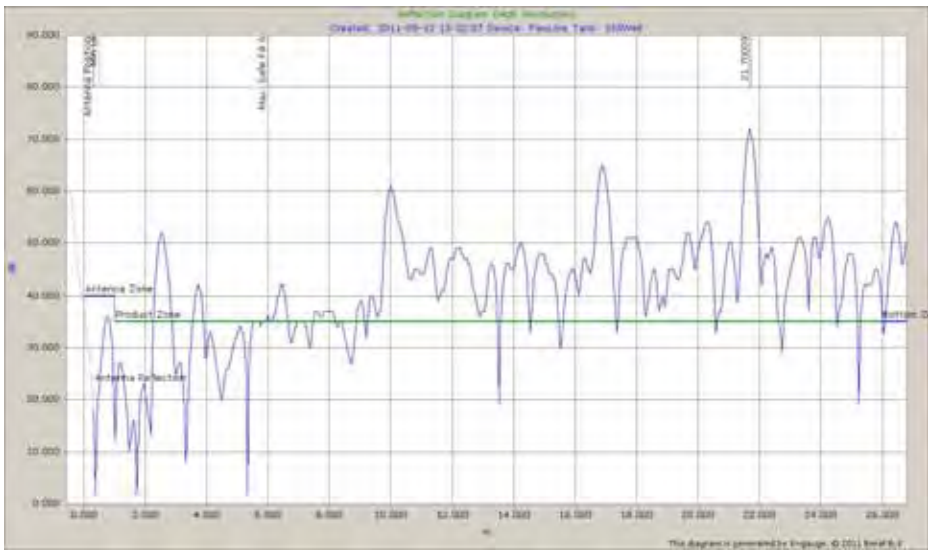


FIGURE 6-17 Verification pin measuring mode, reflection diagram example

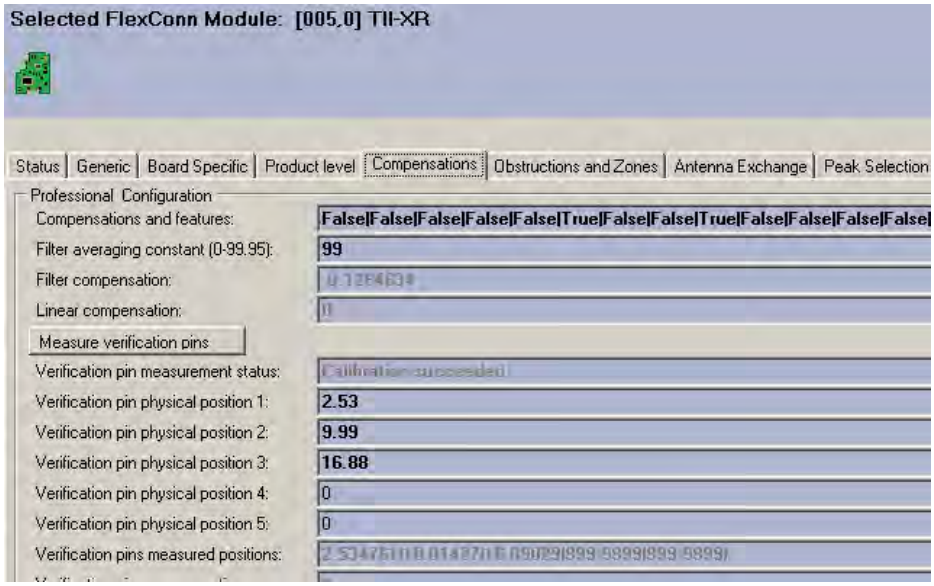


FIGURE 6-18 Verification pin compensation, example

6.5.2.7 Errors and Warnings

The status code of the [Primary value] or the [Secondary value] can display an error (status = <BAD>) or a warning (status = <UNCERTAIN>).

Most common error messages are:

Message	Cause
Radar max safe fill not set error	[Maximum safe fill] still set to 0 (zero)
Radar max safe fill out of range	[Maximum safe fill] value too high

6.5.2.8 Additional Information

Following information can be extracted from the TII-XR system:

Entity	Description
[DSP firmware version]	Besides a generic processor, the TII-XR has a Digital Signal Processor for algorithm calculations. See also FIGURE 6-6.
[Production date]	Production date of the complete SmartRadar FlexConn system.
[ART2A serial number]	The serial number of the high-frequency module. This module does all measurements.
[Device serial number]	Serial number of the complete SmartRadar FlexConn system.
[Antenna serial number]	Serial number of the measuring antenna.

6.5.2.9 Overfill Protection Application

For the configuration of the TII-XR within an Overfill protection application, see 6.6.11.

6.6 Relay Contacts (FII-DO)

6.6.1 Introduction

The Field Interface Instrument - Digital Output (FII-DO) board has 4 software-controlled, electromechanical relays; see FIGURE 6-19.

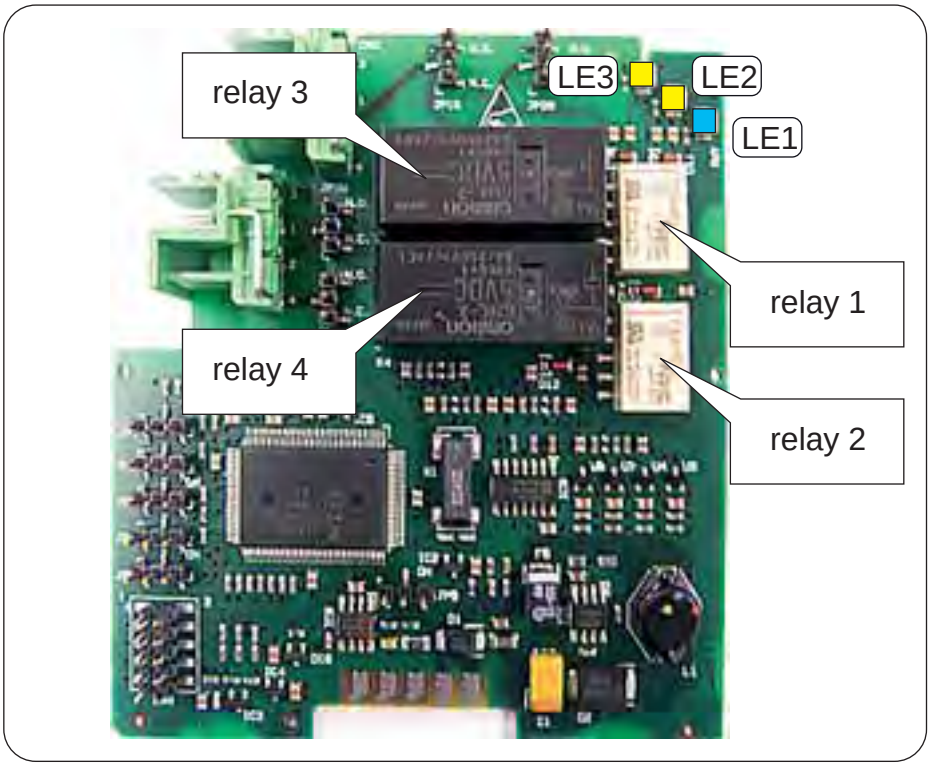


FIGURE 6-19 The relays and LEDs on the FII-DO board

ESF07-0001

These relays are allocated to FlexConn functions as shown below:

Function Number	Function
1	Relay 1
2	Relay 2
3	Relay 3
4	Relay 4

The relays have output status read-back lines.

With jumpers, the relays can individually be set to Normally Open (NO) or Normally Closed (NC).

In addition to the board's [Health] LED LE1, the LEDs LE2 and LE3 are available (see FIGURE 6-19). They can be associated to a relay, by setting the [LED Association] entity.

☛For a *fail-safe level application*, continue with section 6.6.10.

6.6.2 Operation Mode

The FII-DO can operate in one of two modes: [Alarm Mode] and [Fallback Mode]. This is controlled by the [Operation Mode] entity.

Fallback Mode is *not* implemented yet.

☛Set the [Operation Mode] entity to [Alarm Mode].

6.6.3 Relay Configuration

6.6.3.1 Jumper Settings

At installation, each individual relay contact was configured as required with the hardware jumpers JPx0, where x = Relay 1 to 4 respectively. See FIGURE 6-20.

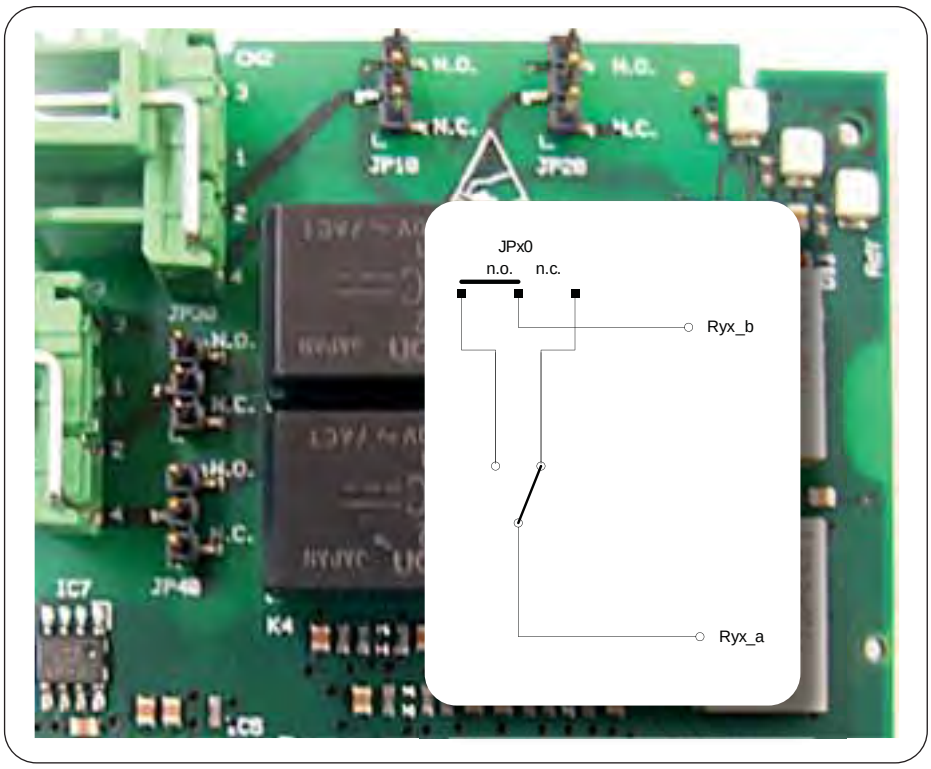


FIGURE 6-20 The relays' hardware jumpers

ESF07-0002

NOTE: In the Commissioning stage, no jumper setting can be changed without breaking the compartment screw sealing.

6.6.3.2 Relay Mode

Each individual relay can be set to be *energized* or *de-energized* during operation, by setting the [Relay Mode] entity to <Energized> or <De-energized> respectively.

If the [Relay Mode] entity is set to <Energized>, the relay coil will be energized when the relay state is <Deactivated>, and the relay coil will be de-energized when the relay state is <Activated>.

If the [Relay Mode] entity is set to <De-Energized>, the relay coil will be de-energized when the relay state is <Deactivated>, and the relay coil will be energized when the relay state is <Activated>.

The <Energized> option is used for *fail-safe* operation whereas the <De-Energized> option is used for *non-fail-safe* operation.

☛Set each individual relay to the required configuration, by selecting the proper entities. See also next overview (fail-safe configuration is coloured).

Physically Configured	Relay Mode	Relay State	Physical Result
Normally Open (NO)	De-Energized	Activated	Closed
		Deactivated	Open
	Energized	Activated	Open
		Deactivated	Closed
Normally Closed (NC)	De-Energized	Activated	Open
		Deactivated	Closed
	Energized	Activated	Closed
		Deactivated	Open

6.6.4 Alarm Mode

Each individual relay can operate in one out of three modes, by setting the [Alarm Mode] entity to either [PV Monitor], [Remote Control], or [Not In Use].

6.6.4.1 PV Monitor

In [PV Monitor] mode, each individual FII-DO-relay unit can monitor the Primary Value (PV) or Secondary Value (SV) of another board connected to the CAN bus, and either activate or deactivate the associated relay if a certain condition is <True> or <False>.

☛If [Remote Control] or [Not In Use] mode must be selected, skip to section 6.6.4.2 or 6.6.4.3 respectively.

☛From the [Alarm Mode] menu, select [PV Monitor].

☛Select [Monitor Board ID], set proper value.

☛Select [Monitor Board Instance], set proper value.

☛Select [Monitor Function Instance], set proper value.

☛Select [Monitor Source], select either <PV> or <SV>, as desired.

The [Monitor Board ID], [Monitor Board Instance], and [Monitor Function Instance] entities determine the *location* of the entity to be scanned.

The [Monitor Source] entity determines if either the Primary Value <PV> or Secondary Value <SV> entity shall be scanned.

The behavior of each individual relay in PV Monitor mode is further controlled by the [Monitor Mode] and the [Status Behavior] entities; see next.

6.6.4.1.1 *Monitor Mode*

The [Monitor Mode] entity can either be set to [Remote] or [Local].

- If the [Monitor Mode] is set to [Remote], the *alarm status* of the scanned PV or SV is monitored. The alarm status is compared against the value set in the [Remote Threshold Source] entity. The [Remote Threshold Source] entity can be set to <HH>, <HA>, <LA>, or <LL>.

Example: If the [Remote Threshold Source] is set to <HH> and a High High Alarm occurs, the relay will be activated. It will not be activated by any other alarms.

☛ If [Local] [Monitor Mode] is to be set, skip to next bullet (■).

☛ From the [Monitor Mode], select [Remote].

☛ Select [Remote Threshold Source], set desired value.

- If the [Monitor Mode] is set to [Local], the scanned PV or SV value is compared against the value set in the [Threshold] entity. The behavior is modified by the [Threshold Mode] and the [Hysteresis] entities. The [Threshold Mode] entity can be set to either <Treat as HA> or <Treat as LA>.

  If the [Threshold Mode] entity is set to <Treat as HA>, the relay is activated if the scanned PV or SV is greater than or equal to the [Threshold] entity value, and the relay is deactivated if the scanned PV or SV is less than the [Threshold] entity value minus the [Hysteresis] entity value.

  If the [Threshold Mode] entity is set to <Treat as LA>, the relay is activated if the scanned PV or SV is greater than or equal to the [Threshold] entity value, and the relay is deactivated if the scanned PV or SV is less than the [Threshold] entity value plus the [Hysteresis] entity value.

☛ From the [Monitor Mode], select [Local].

☛ Select [Threshold Mode], and choose either <Treat as HA> or <Treat as LA>.

☛ Select [Hysteresis], set desired value.

6.6.4.1.2 *Status Behavior*

The Status Behavior entity determines what happens to the relay if the health of the scanned PV or SV differs from Good. The [Status Behavior] should be set to one of the following options: <BAD>, <BAD-UNCERTAIN>, or <Not Used>.

- If the [Status Behavior] is set to <BAD>, and the scanned PV or SV health is Bad, the respective relay will be activated.
- If the [Status Behavior] is set to <BAD-UNCERTAIN>, and the scanned PV or SV health is Bad or Uncertain, the respective relay will be activated.
- If the [Status Behavior] is set to <Not Used>, the respective relay will *not* be activated if the scanned PV or SV health is Bad or Uncertain.

☛ Set the [Status Behavior] entity either to <BAD>, <BAD-UNCERTAIN>, or <Not Used>.

NOTE: This behavior takes priority over the [Remote] or [Local] monitoring. For example: If the [Status Behavior] is set to <BAD>, and the scanned PV or SV health is Bad, the respective relay will be activated regardless of the [Monitor Mode] entity settings. The [Remote] or [Local] option PV or SV checks will then not affect the relay status.

6.6.4.2 Remote Control

In [Remote Control] mode, each individual relay can directly be activated or deactivated, by sending an !Activate! respectively a !Deactivate! command via the CAN bus.

The behavior of each individual relay is further controlled by the [Remote Control] mode entity, which can be set to either <Restricted> or <Not Restricted>.

- If the [Remote Control] mode entity is set to <Not Restricted>, any source can be used to control the relay with an !Activate! or a !Deactivate! command.
- If the [Remote Control] mode entity is set to <Restricted>, the relay can only be controlled by the source that matches the values set in the [Control Board ID], the [Control Board Instance], and the [Control Function Instance].

Engauge SmartView

☛ From the [Remote Control] mode menu, select either <Restricted> or <Not Restricted>.

☛ If Not Restricted was selected, skip to 6.6.4.3.

☛ Select [Control Board ID], set proper value.

☛ Select [Control Board Instance], set proper value.

☛ Select [Control Function Instance], set proper value.

6.6.4.3 Not in Use

If an individual relay is not required in a particular application, the [Alarm Mode] entity must be set to <Not In Use>.

Example: If a particular application requires only two relays to be used, say relay 1 and 2, then for relay 3 and 4 the [Alarm Mode] entities must be set to <Not In Use>.

Engauge SmartView

☛ For the FII-DO relays *not used* within the application, set the [Alarm Mode] entities to <Not In Use>.

6.6.5 Commands

The following commands can be given to the FII-DO:

- Activate
- Deactivate
- Acknowledge

6.6.5.1 Activate

The !Activate! command will cause the specified relay to become <Activated>. This command is only available in [Remote Control] mode; see 6.6.4.2.

The !Activate! command behavior is modified by the [Time Setting] entity. If the [Time Setting] entity is set to zero, the relay will stay permanently activated until a !Deactivate! command is given.

If the [Time Setting] entity is set to a value other than zero, the relay will be activated for a time in seconds equal to the value set in the [Time Setting] entity, then deactivated. During the period the relay is activated, the relay state will be !Time Setting Active!. This is useful for site commissioning.

☛For each relay, set the [Time Setting] entity to the desired value.

6.6.5.2 Deactivate

The !Deactivate! command will cause the specified relay to become <Deactivated>. This command is only available in [Remote Control] mode; see 6.6.4.2.

6.6.5.3 Acknowledge

The !Acknowledge! command will cause the specified relay to be physically deactivated, but the relay status will be set to !Acknowledged!. This command is only available in [PV Monitor] mode; see 6.6.4.1. This command can only be given when the concerned relay has already been activated.

For example, this command is useful if the relay is connected to an alarm system. The alarm can be silenced by the command, but it is still possible to determine if an alarm has occurred. When the alarm condition is then removed, the relay state will become deactivated, and normal operation will resume.

6.6.6 LED Association

Depending on the value set in the [LED Association] entity, the 4 individual relays on the FII-DO board can be associated with one out of 2 LEDs, LE2 or LE3 (see FIGURE 6-19).

The associated LED will be ON when the relay state is <Activated>, and the LED will be OFF when the relay state is <Deactivated>.

*NOTE: The LEDs do **not** indicate the **physical** relay state (coil state or contacts state), as this depends on the software settings and the physical settings (jumper), see 6.6.3.*

☛ Set the value of the [LED Association] entity as desired (optional). For an example, see table below.

LED Association	LED Number	Relay Number
1 + 2	LE2	1
	LE3	2
3 + 4	LE2	3
	LE3	4

6.6.7 Terminal Allocation

Terminal Number	Name	Function
14	Ry1_a	Relay 1 Common
15	Ry1_b	Relay 1 NO or NC*
16	Ry2_a	Relay 2 Common
17	Ry2_b	Relay 2 NO or NC*
18	Ry3_a	Relay 3 Common
19	Ry3_b	Relay 3 NO or NC*
20	Ry4_a	Relay 4 Common
21	Ry4_b	Relay 4 NO or NC*

*) See jumper settings, section 6.6.3.1.

6.6.8 Commissioned Entities

☛By using the table below, make sure all entities are commissioned.

The [Commissioned] entity will display either <True> if the function is commissioned or <False> if the function is not commissioned. To commission the function, the entities must be set in accordance with the table below.

Operation Mode	Alarm Mode	Remote Control Mode	Parameters	Commissioned
Alarm Mode	Remote Control	Restricted	[Control Board ID] >=1 and <=255 [Control Board Instance] >=0 and <=7 [Control Function Instance] >=1 and <=15 [Time Setting] = 0	<True>
			[Control Board ID] <1 or >255 [Control Board Instance] <0 and >7 [Control Function Instance] <1 and >15 [Time Setting] ≠ 0	<False>
		Not Restricted	[Time Setting] = 0	<True>
			[Time Setting] ≠ 0	<False>
	PV Monitor	Remote	[Monitor Board ID] >=1 and <=255 [Monitor Board Instance] >=0 and <=7 [Monitor Function Instance] >=1 and <=15 [Time Setting] = 0	<True>
			[Monitor Board ID] <1 or >255 [Monitor Board Instance] <0 and >7 [Monitor Function Instance] <1 and >15 [Time Setting] ≠ 0	<False>
		Local	[Monitor Board ID] >=1 and <=255 [Monitor Board Instance] >=0 and <=7 [Monitor Function Instance] >=1 and <=15 [Time Setting] = 0 [Threshold] = value entered [Hysteresis] = value entered	<True>
			[Monitor Board ID] <1 or >255 [Monitor Board Instance] <0 and >7 [Monitor Function Instance] <1 and >15 [Time Setting] ≠ 0 [Threshold] = value entered [Hysteresis] = value entered	<False>
	Not In Use	N/A	N/A	<True>
Fallback Mode	N/A	N/A	N/A	<False>

6.6.9 Board Commissioned Entity

The [Board Commissioned] entity will display either <True> if all functions are commissioned or <False> if any of the functions are not commissioned.

☛ If the [Board Commissioned] entity displays <False>, check each function parameter again. Use the table from 6.6.8.

6.6.10 Fail-safe Level Application

Following steps include all commissioning-aspects settings for the Fail-safe level application.

☛ The corresponding jumper of the concerned relay must be in the Normally Open (NO) state (= *default* setting).

NOTE: In the Commissioning stage, no jumper setting can be changed without breaking the compartment screw sealing. See also section 6.6.3.1.

☛ Set [Operation Mode] to [Alarm Mode].

☛ Set [Relay Mode] to <Energized>.

☛ Set [Alarm Mode] to [PV Monitor].

☛ Set [Monitor Board ID] to <board id> of product-level board.

☛ Set [Monitor Board Instance] to <board instance> of related product-level board.

☛ Set [Monitor Function Instance] to <function instance> of related product-level board.

☛ Set [Monitor Source] to <PV>.

☛ Set [Monitor Mode] to [Remote].

☛ Set [Remote Threshold Source] to <HH>, <HA>, <LA>, or <LL>.

☛ Set corresponding alarm setting of the related product-level board.

☛ Set [Status Behavior] to <BAD-UNCERTAIN>

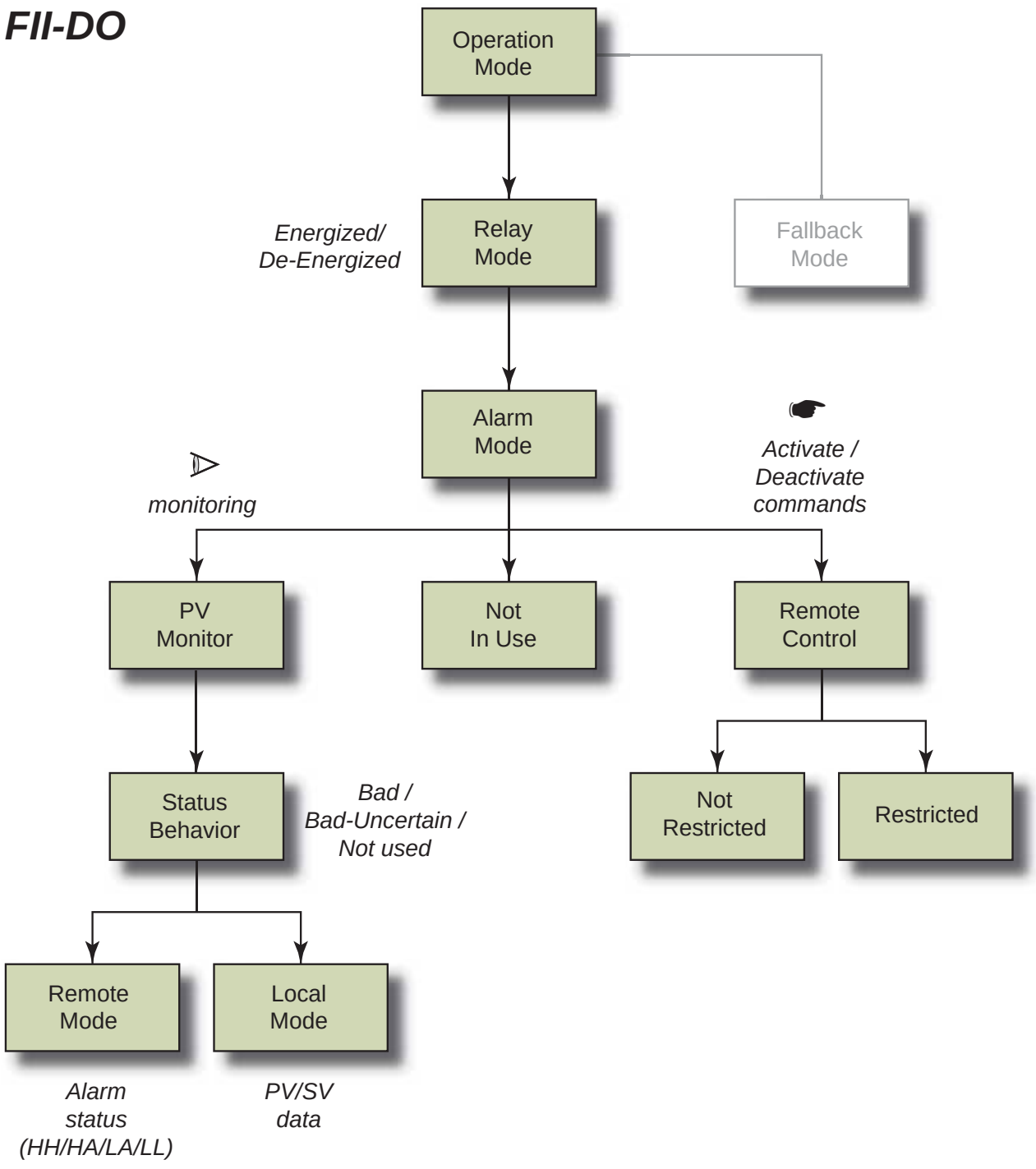


FIGURE 6-21 FII-DO operation mode survey

ESF07-0004

6.6.11 Overfill Protection Application

6.6.11.1 Introduction

Because of some tank storage overfill accidents in the past, there is an increased need for a qualified overfill-protected level measuring system.

The SmartRadar FlexLine can be configured such that an adequate overfill protection level is achieved. As such it is qualified as a Safety Instrumented Function (SIF) for overfill protection of storage tanks in the oil and gas industry, to a SIL[1] 2 level.

The safety parameters are within the range of SIL 2 if the following conditions are met:

- **The SmartRadar FlexLine uses the Overfill Protection Application with the dual redundant configuration of the FII-DO as described in this manual, and**
- **All relevant entities are commissioned as decribed in this manual.**

6.6.11.2 Essential FlexConn Boards

The essential FlexConn boards for an overfill protection application are:

- FII-DO (1)
- FII-DO (2)
- TII-XR
- PSX

6.6.11.3 Application Principle

- In order to achieve the correct SIL, **2 SmartRadar FII-DO modules are combined into a special safety configuration**.
- For this special configuration, **only relay 3 and relay 4 are used**. For their locations, see FIGURE 6-22.

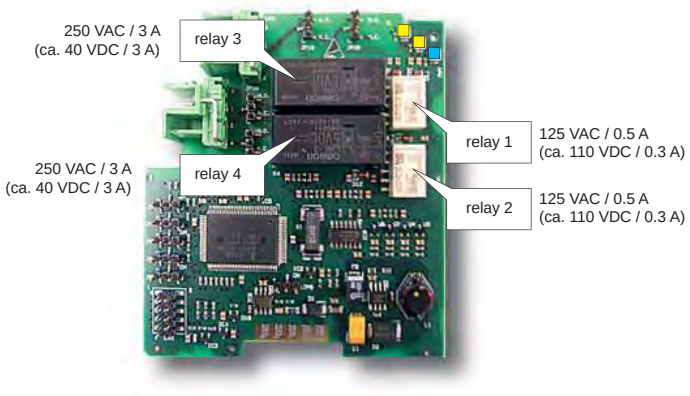


FIGURE 6-22 Locations and ratings of the Electro Mechanical Relays on the FII-DO board ESF10-0001

1. SIL = Safety Integrity Level.

- The relays must be set to **Normally Open** (jumper, see 6.6.3.1) and **Normally Energized** (configuration parameter, see 6.6.3.2).
- In a normal situation, the relay contacts are closed.
- Relays 4 are used to increase the availability: if a problem is detected with the other relays, the redundancy takes care that the overfill protection function will work (see also FIGURE 6-23).
- The relays typically can stop a pump or close a valve that is used filling a storage tank. See FIGURE 6-23.
- Overfill safety analysis, including diagnostic tests is done every second.
- The 2 FII-DO boards are continuously checking each other for a correct functioning. This is done every second. In case of malfunction, 2 retries are executed before the status is definitely determined.
- The radar scans the overfill protection status every second and will react accordingly.

6.6.11.4 Overfill Protection Board Actions

The following table shows the important parameters for overfill protection.

Output = Function PV	
1	= relay contact closed
0	= relay contact opened (safe situation)
Diagnostics = Function health + Board health	
1	= status = GOOD, healthy
0	= status = BAD, UNCERTAIN, not healthy (force safe situation)
Level = product level analysis	
1	= product level < threshold
0	= product level >= threshold (force safe situation)
0	= product level status = BAD, UNCERTAIN, not healthy
0	= no communication with the TII-XR
Voltage = all FlexConn monitored voltages	
1	= voltage within specifications (OK)
0	= voltage too high (one or more) (force safe situation)
Counter part communication = communication with other relay board	
1	= valid communication
0	= no communication (force safe situation)

- **Both board contacts are always opened** if **one** out of the following events occurs:
  - **Level = 0** (product level >= threshold, product level TV = BAD/ UNCERTAIN, TII-XR board does not respond)
  - **Voltage = 0** (one of more board voltages out of range)
  - **Board diagnostic = 0** (board status = BAD / UNCERTAIN)
  - **Board diagnostic of counter part (redundant board) = 0** (board status = BAD / UNCERTAIN)
  - **Counter part (redundant board) communication = 0** (other relay board does not respond)

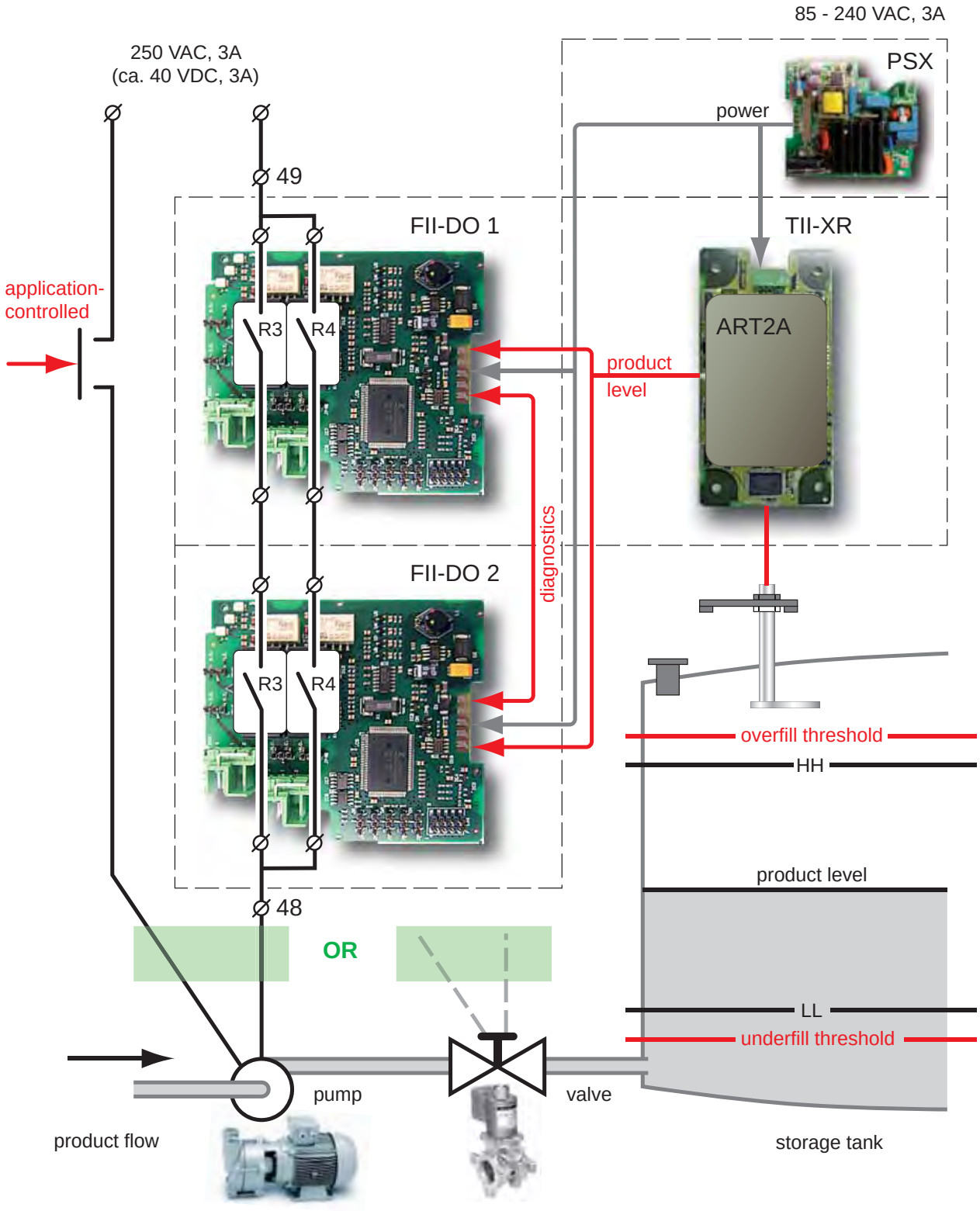


FIGURE 6-23 Overfill protection application using 2 FII-DO boards

ESF10-0002

- **An individual board relay contact is closed** if **all** following conditions are met:
  - **Level = 1** (product level < threshold, product level TV = GOOD, valid communication with TII-XR)
  - **Voltage = 1** (board voltages within ranges)
  - **Board diagnostic = 1** (board status = GOOD)
  - **Board diagnostic counter part = 1** (board status = GOOD)
  - **Counter part = 1** (other relay board responds)
  - **Relay (Rn) diagnostic = 1** (function status = GOOD)
  - **Relay (Rn) diagnostic counter part = 1** (function status = GOOD)

*NOTE: Both boards needs to be configured **identically** for relay behaviour, threshold, and hysteresis.*

The following matrix gives an overview of the relations between the status and resulting events:

SD = Shut Down **O = Overfill alarm** **N = No**

NO = Normal Operation **W = Gauge alarm (warning)** **Y = Yes**

H = Healthy

	1	2	3	4	5				6	7	8	9	10	11	12	13	14
Own board status																	
Level (incl. TII-XR comms + TV Health + status check)	0	X	X	X	X				1	1	1	1	1	1	1	1	1
Voltage	X	0	X	X	X				1	1	1	1	1	1	1	1	1
Diag board	X	X	0	X	X				1	1	1	1	1	1	1	1	1
Diag R3	X	X	X	X	X				0	0	0	1	1	1	1	1	1
Diag R4	X	X	X	X	X				1	1	1	0	0	0	1	1	1
Counter part (redundant board) communication	X	X	X	0	X				1	1	1	1	1	1	1	1	1
Other board status																	
Diag board (incl. Voltage)	X	X	X	X	0				1	1	1	1	1	1	1	1	1
Diag R3	X	X	X	X	X				0	1	1	0	1	1	0	1	1
Diag R4	X	X	X	X	X				1	0	1	1	0	1	1	0	1
Board action																	
Output R3	0	0	0	0	0				0	0	0	0	1	1	0	1	1
Output R4	0	0	0	0	0				1	0	1	0	0	0	1	0	1
Application status	SD	SD	SD	SD	SD				NO	SD	NO	SD	NO	NO	NO	NO	NO
Overfill Protection Status	O	W	W	W	W				W	W	W	W	W	W	W	W	H
Start safety timer	N	N	N	N	N				Y	N	Y	N	Y	Y	Y	Y	N

6.6.11.5 Merging the Status to GPU-level status

The TII-XR firmware implements an alarm for the operator by merging the output status of each board with the GPU level status, in order to communicate shut down information to the control room. See following matrix.

NOTE: For field installations upgraded with the Overfill Protection functionality, the TII-XR firmware must be upgraded.

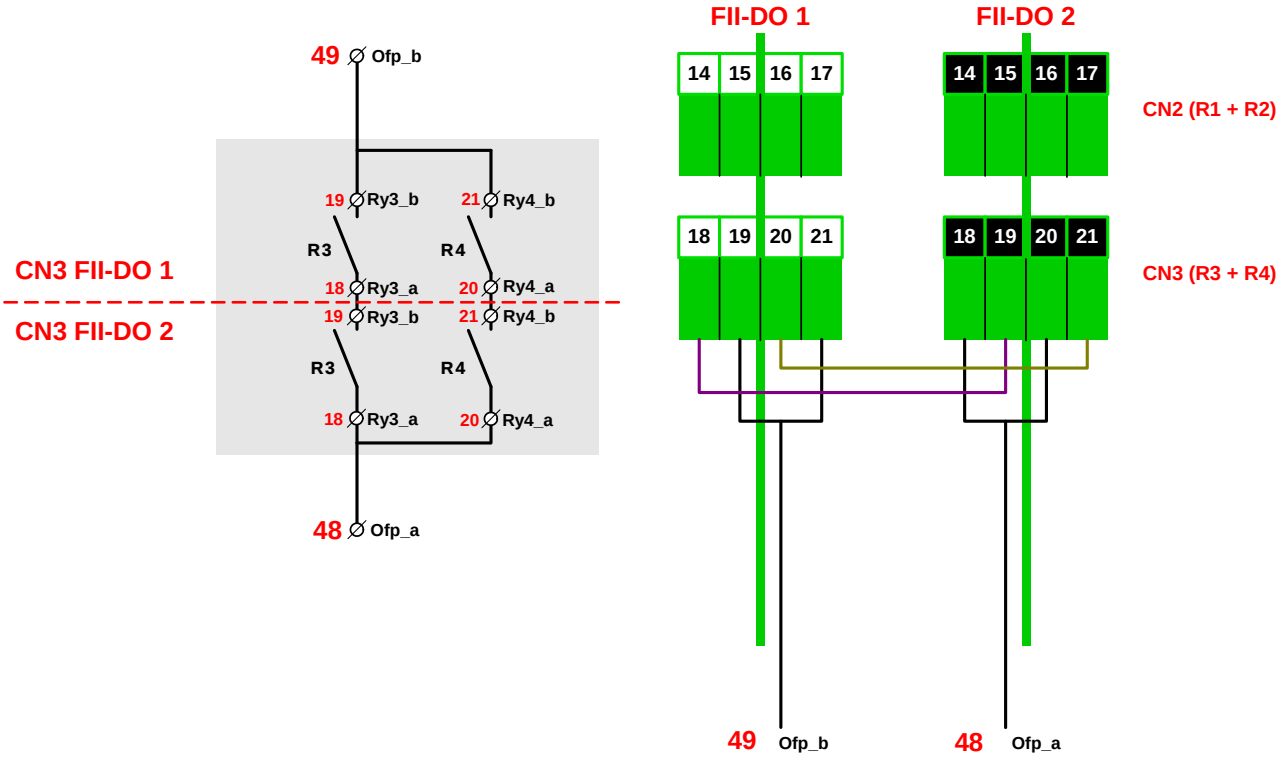
F = Fail
? = Warning, reduced accuracy
- = valid

FII-DO 1	FII-DO 2	TII-XR
Overfill Protection status	Overfill Protection status	level status GPU protocol
O	O	F
O	H	F
O	W	F
W	O	F
W	H	?
W	W	?
H	O	F
H	H	-
H	W	?
no comms	X	F
X	no comms	F

6.6.11.6 Overfill Protection Application Wiring

☛Connect the external wiring (see illustrations below):

- Connect terminal 48 to the pump or to the valve.
- Connect terminal 49 to the mains.



6.6.11.7 Commissioning the Overfill Protection Application

To configure the Overfill Protection Application all essential boards needs to be configured.

6.6.11.7.1 FII-DO (redundant)

☛Make sure all jumpers are set to **Normally Open** (N.O.). See 6.6.3.1.

Engauge
SmartView

☛Set the [Board Instance] entity of each FII-DO board to a different value (e.g. 0 and 1).
The boards are redundant and share the same board ID, so to be able to address the board uniquely by the internal (CAN-bus) or external FlexConn protocol, the board instance must be different to distinguish the boards from each other.

☛Set the [Counterpart Board Instance] entity of each FII-DO board to the [Board instance] of the *counterpart* FII-DO board (redundant board).

☛ Set the [Relay Mode] entity of R3 and R4 relay to <Normally Energized> for both FII-DO boards.

☛ Set the [Alarm Mode] entity of R3 and R4 relay to <PV Monitoring> for both FII-DO boards.

☛ Set the [Monitor Mode] entity of R3 and R4 relay to <Local> for both FII-DO boards.

☛ Set the [Threshold] entity and [Hysteresis] entity of R3 and R4 relay to the application-specific desired values, for both FII-DO boards **identically**.

☛ For *overfill* protection, configure the [Threshold] entity above the HA and HH setting of the TII-XR board. Entities [High alarm] and [High high alarm].

☛ For *underfill* protection, configure the [Threshold] entity below the LA and LL setting of the TII-XR board. Entities [Low alarm] and [Low low alarm].

☛ For *overfill* protection, configure the [Threshold Mode] entity of R3 and R4 relay to <Treat as HA> for both FII-DO boards.
The threshold will now be approached as high alarm above [High alarm] and [High high alarm], with the relevant hystresis behaviour.

☛ For *underfil*l protection, configure the [Threshold Mode] entity of R3 and R4 relay to <Treat as LA> for both FII-DO boards.
The threshold will now be approached as low alarm below [Low alarm] and [Low low alarm], with the relevant hysteresis behaviour.

☛ Set the other relevant entities:

The [Overfill Protection Status] entity shows the Overfill Protection Status of each FII-DO board.

<H> = Healthy

<W> = Gauge alarm (Warning)

<O> = Overfill alarm

With the [Safety shut down timer] entity, the user can set the time that a safe shutdown will be forced when only an error or failure in one relay chain is detected. Default value: <0>: Safety Shutdown Timer DISABLED.

NOTE: This is an enhanced safety function.

When one potential fail situation is detected in one chain, the other chain will be forced to fail safe (contacts opened) after the safety shut down time.

Philosophy: the first detected fail will not result in a shut down directly *but should be solved within a certain time*.

- If the Safety shut down timer is *enabled*, so value ≠ <0>, then operation can continue with one branch till second fault is detected.

In other words, this means: In case an anomaly is deteced by the internal gauge diagnostics, the gauge needs service within the time set by this timer.
Typical value: <72> hours.

- If the Safety shut down time is *disabled*, so value = <0>, then the customer wants to continue permanently with the other branch.

NOTE: When the "Safety shut down timer" is active or running, the remaining time until shutdown can be inspected by reading the [Safety shut down timer left] entity.

6.6.11.7.2 TII-XR

☛ Set the [Overfill Protection Function] entity to <Enabled>.

☛ Set the [First Relay Board Instance] entity of the [Board Instance] entity to the first FII-DO board.

☛ Set the [Second Relay Board Instance] entity of the [Board Instance] entity to the second FII-DO board.

The "Maximum Safe Fill" mechanism of the TII-XR should be ignored for the SmartRadar FlexLine overfill protection application.

When the "Maximum Safe Fill" level is configured lower than the Over fill Threshold, the PV status becomes BAD much earlier, and the FII-DO will open the contacts.

☛ Set the [Maximum safe fill level] entity above the [Threshold] values of the FII-DO boards when used for overfill protection.

OR

☛ Set the 9th switch [Compensations and features] entity to <FALSE>.

6.6.11.7.3 PSX (Power Supply)

CAUTION! The Overfill Protection Application may ONLY be powered by AC mains. Only 85VAC - 240 VAC can be used for mains connected to the SmartRadar FlexLine having the Overfill Protection Application option.

6.6.11.8 Proof Testing

- By activating the command [Start Proof test] entity, the FII-DO simulates an overfill or underfill. The remainder of the SIF should work as expected (e.g. close a valve, stop a pump, generate an alarm) this should be validated.

NOTE: This test must only be performed in a healthy situation when the product level in the tank is below the overfill threshold or above the underfill threshold.

During the proof test - when the level is simulated above or below the threshold - the "Overfill protection status" will indicate "O" in order to enable checking the "Proof test" results in the control room as well.

Each FII-DO of the overfill protection application implements the proof test functionality, so the proof test has to be performed *successively for both modules*.

- By activating the command [Stop Proof test] entity, the FII-DO returns to normal overfill analysis mode again.

NOTE: The FII-DO module of the SmartRadar FlexLine overfill protection safety application implements an automatic termination of the "Proof test" function in case the user forgets the command [Stop Proof test].

☛Set the [Proof test termination time out] entity to the most desired value in *minutes*:

- <0> (auto termination off)
- <5> (default)
- <10>
- <20>
- <30>

6.7 SmartView Display Interface (FII-SMV)

6.7.1 Introduction

The Field Interface Instrument - SmartView (FII-SMV) board is a module that communicates with *SmartView*.

FIGURE 6-24 The FII-SMV board with the *SmartView* display ESF07-0013

At request from *SmartView* the FII-SMV board prepares data sets for it. The requests from *SmartView* depend on the actual screen at the time. The communication between the FII-SMV and *SmartView* uses an own protocol on an RS-485 physical layer.

The *SmartView* display can be delivered in 3 versions, each version having its own specific address:

- Portable *SmartView* (address 1)
- *SmartView* fixed on the instrument (address 2)
- *SmartView* as a tank-side indicator (address 3)

The FII-SMV board continuously scans all addresses, and only the one with the lowest address will be served.

So, for example, if a stand-alone SmartView (address 3) and an integrated SmartView (address 2) are connected, the stand-alone SmartView (address 3) will be served as soon as the integrated SmartView (address 2) is closed (set to idle).

6.7.2 Commissioning the FII-SMV

For a correct functioning of the FII-SMV module in an instrument the following entities can be set by using either *Engauge* or *SmartView*.

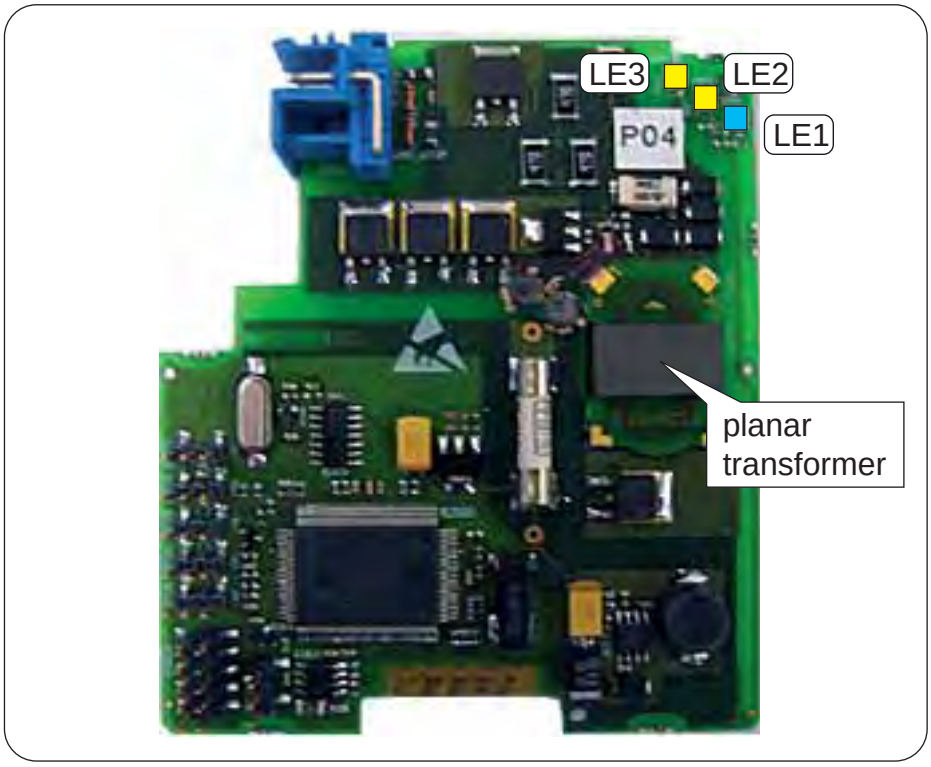
☛By using the following table, check each entity for correctness.

Name	Value Range	Default Value	Explanation
[Decimal separator]	<point> <comma>	<point>	The decimal separator in which entities are shown on the *SmartView* display.
[Tenth millimeter selection]	<enable> <disable>	<enable>	Determines whether the tenth millimeter is shown on the display in the [PV screen] in case a level entity is shown.
[Identification]	8 characters e.g. <TANK1234>	<-------->	Name of a tank or instrument. This string is visible within a [PV screen].
[Password]	<.....> 6 characters	<ENRAF2>	The password *SmartView* uses for entering the protected level. Note: Some settings reside under the protected level.
[Function identification]	<.....> 13 characters	<SmartView mst>	The name of the current function of this module. This name is visible on the *SmartView* display.
[Extra information switch]	<level temperature> <Info Switch>	<Info Switch>	Determines whether the [extra information] screen on the *SmartView* will display level and temperature or extra information from a specific function.
[Extra info board ID]	<01.....XX> 2 digits	<01>	Board ID of the board that has the [extra information] to display. In case of OneWireless, the ID = 12.
[Extra info board instance]	<00.....XX> 2 digits	<00>	Board instance of the board that has the [extra information] to display.
[Extra info function instance]	<01.....XX> 2 digits	<01>	Function instance that has extra information to display. In case of OneWireless, this = 01.

6.8 Pressure & Density Measurement and Other HART Inputs (FCI-HT)

6.8.1 Introduction

The Field Communication Instrument - HART (FCI-HT) board is a HART®[1] master module that enables hybrid-signal (both analog + digital) communication between the FlexConn instrument and a HART sensor.



ESF07-0014

FIGURE 6-25 The FCI-HT board

The HART protocol is a bi-directional master-slave communication protocol, which is used to communicate between intelligent field instruments and host systems.

The FCI-HT board has a planar transformer for galvanic isolation from the HART bus. See FIGURE 6-25.

LED LE1 is the board's [Health] LED. LEDs LE2 and LE3 will be flashing to indicate activity on the HART bus. LE2 indicates data is being transmitted (Tx), LE3 indicates data is being received (Rx).

With the HART protocol, an analog 4-20 mA signal can be combined with a digital Frequency Shift Keying (FSK) signal. See FIGURE 6-26.

1. Highway Addressable Remote Transducer.

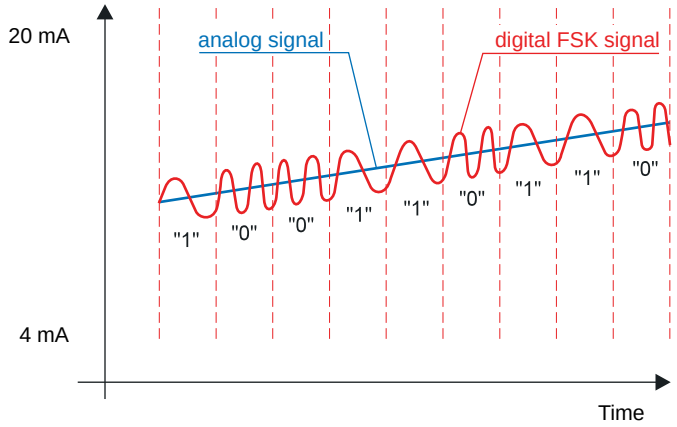


FIGURE 6-26 The analog and digital signals within the HART® communication ESF07-0015

6.8.2 Software Description

The FCI-HT board, being a functional module of the SmartRadar FlexLine, contains embedded software which enables it to collect data input from sensors via both the HART bus and the FlexConn CAN bus.

Moreover the FCI-HT module can calculate the HIMS[1] product density.

The *main* function of the FCI-HT software is to measure HIMS product density, by connecting the FCI-HT board via the HART bus to 1 or 2 pressure sensors, and via the FlexConn bus to a product level and a water level sensor.

To measure product density, the needed standard system configuration is:

- HART pressure sensor P1 (product pressure)
- HART pressure sensor P3 (vapour pressure)
- Product level scanned from a FlexConn board (e.g. TII-XR)
- Water level scanned from a FlexConn board (e.g. FII-VT)

For tanks that are free venting to the atmosphere or floating-roof tanks, P3 pressure is not required. The water level sensor is also optional.

1. Hybrid Inventory Measurement System.

For HIMS density measurement system diagrams, see FIGURE 6-27 and FIGURE 6-28.

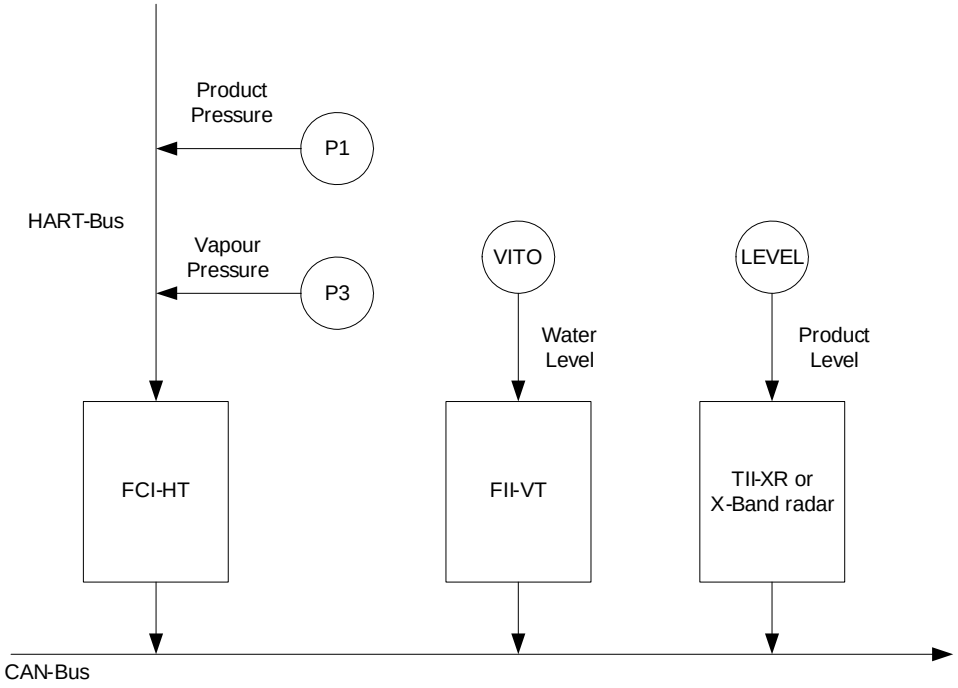


FIGURE 6-27 Standard HIMS density measurement system diagram

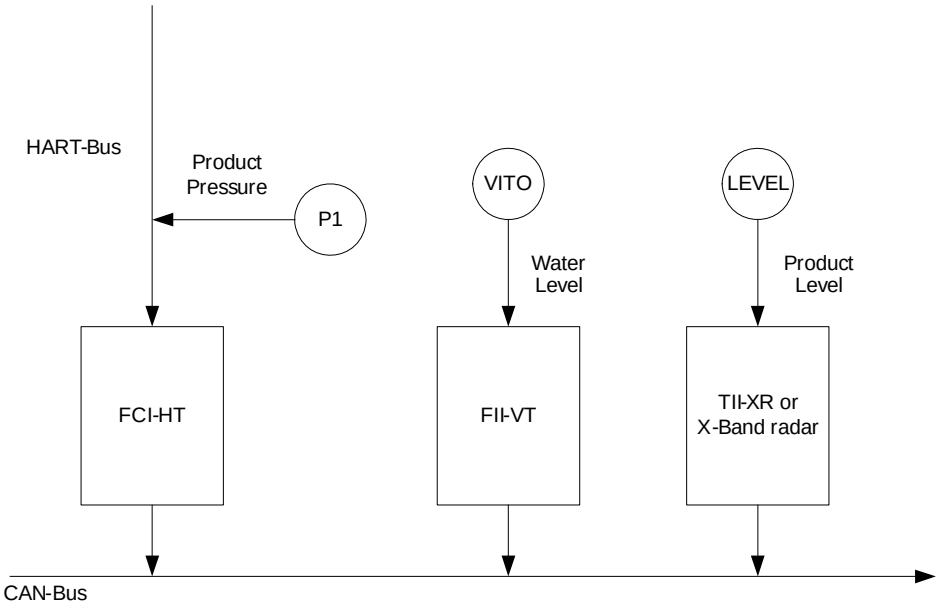


FIGURE 6-28 Floating-roof or free-venting tank HIMS density measurement system diagram

As an *alternative* function, the FCI-HT board also allows the connection of up to 5 generic HART sensors operating in *multi-drop digital* mode or one generic HART sensor operating in *analog* mode.

In the multi-drop digital mode situation, one or two of the generic HART sensors can be [P1 Pressure] or [P3 Pressure], providing product pressure and vapour pressure respectively, but no HIMS density calculation will be available.

The HART sensors and HIMS density measurement are allocated to a function number in the FCI-HT software. See table below.

FlexConn Function	Device Type
Function 1	[P1 Pressure]
Function 2	[P3 Pressure]
Function 3	[Distance]
Function 4	[Temperature]
Function 5	[Pressure]
Function 6	[Density]
Function 7	[Other]
Function 8	[HIMS Density]

TABLE 6-1 FlexConn function allocation

Function 1 is exclusively reserved for P1 pressure, Function 2 is exclusively reserved for P3 pressure, and Function 8 is exclusively reserved for HIMS density calculation.

Only one of each type of HART device can be allocated to a function. Therefore this limits the number of HART devices of each type that can be fitted.

Example 1

4 HART pressure devices and 1 temperature device can be connected.

- P1 pressure device allocated to Function 1
- P3 pressure device allocated to Function 2
- one pressure device allocated to Function 5
- one pressure device allocated to Function 7
- the temperature device allocated to Function 4

Example 2

2 HART density devices and 1 distance device can be connected.

- density device 1 allocated to Function 6
- density device 2 allocated to Function 7
- the distance device allocated to Function 3

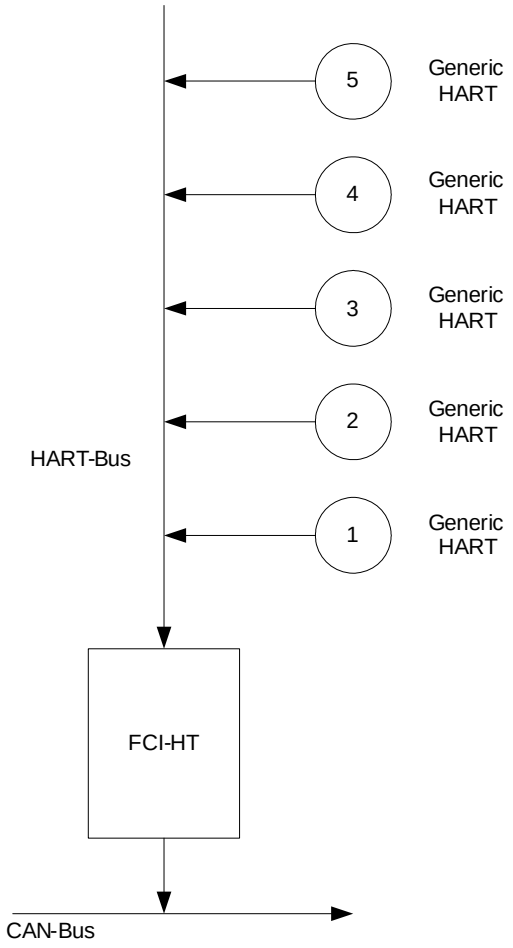


FIGURE 6-29 Alternate system diagram multi-drop digital mode

In analog mode, the connected HART device will be allocated to Function 1 through 7, depending on the type of HART device connected.

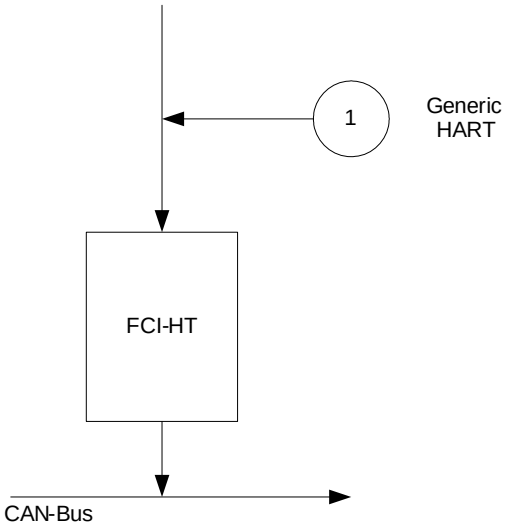


FIGURE 6-30 Analog mode system diagram

6.8.3 Software Specifications

6.8.3.1 General

The *main* function of the FCI-HT software is to measure HIMS product density, by connecting the FCI-HT board via the HART bus to 2 pressure sensors (P1 and P3), and via the FlexConn bus to a product level sensor and an optional water level sensor.

The *alternative* function is to connect up to 5 generic HART devices operating in multi-drop digital mode, or 1 generic HART device operating in analog mode.

The FCI-HT software only supports HART devices with the following addresses.

HART Address	Function
00	Reserved for HART device in analog mode
01	Reserved for P1 pressure sensor
02	N/A Reserved for future use
03	Reserved for P3 pressure sensor
04	HART generic sensor

HART Address	Function
05	HART generic sensor
06	HART generic sensor
07	HART generic sensor
08	HART generic sensor
09	HART generic sensor
10	HART generic sensor
11	HART generic sensor
12	HART generic sensor
13	HART generic sensor
14	HART generic sensor
15	HART generic sensor

TABLE 6-2 Accepted HART addresses

☛Before proceeding with commissioning, first check the maximum start-up current of all connected HART devices.

☛Make sure the HART address of the installed device(s) are in accordance with TABLE 6-2.

6.8.3.2 P1 Pressure

The FCI-HT software only accepts the Primary Value of a P1 pressure HART device in SI units kilo Pascals (kPa).

☛Make sure the P1 pressure HART device is configured to output data in kilo Pascals (kPa). If not, correctly configure as yet, by using an appropriate HART configuration tool.

Sensor Type	Accepted HART PV Unit	Abbreviation	HART PV Unit Code
P1 Pressure	Kilo Pascal	kPa	12

TABLE 6-3 Accepted PV unit for a P1 HART device

NOTE: The Secondary and Tertiary values of a P1 pressure HART device may be any units.

The PV of the P1 pressure HART device is read and converted into SI Units Pascals (Pa) within the FlexConn function PV.

The value is filtered, and the filtering factor depends on the value set in the entity [P1 Integration time]. A higher value gives more filtering, and a lower value gives less filtering.

The correction factor stored in the [P1 PV offset] entity is then subtracted from the filtered value. If the [P1 PV offset] entity = 0 no offset is applied.

Depending on the [PV selected type] entity, the P1 pressure can be displayed as either absolute pressure or relative pressure.

PV Unit Type	Display Unit Type	PV selected type
P1 Pressure	Absolute	1
	Relative	2

TABLE 6-4 P1 pressure displayed unit types

If Relative pressure is selected, the value stored in the [Ambient Air Pressure] entity is added to the measured pressure. If Absolute pressure is selected, no factor is added. The final result is available in the [Primary Value] entity.

NOTE: Absolute pressure is used in the density calculation; the relative pressure is only displayed in P1 [Primary Value].

For the FCI-HT software to differentiate between a HART device malfunction and a HART device not actually installed, P1 pressure has the entity [P1 Installed] which must be set to either <Installed> if a P1 pressure HART device is actually fitted or <Not Installed> if a P1 pressure HART device is *not* actually fitted.

The Secondary and Tertiary values of a P1 pressure HART device are not converted, and they are simply translated from the HART device to the FlexConn environment.

6.8.3.3 P3 Pressure

The FCI-HT software only accepts the Primary Value of a P3 pressure HART device in SI units kilo Pascals (kPa).

☛ Make sure the P3 pressure HART device is configured to output data in kilo Pascals (kPa). If not, correctly configure as yet, by using an appropriate HART configuration tool.

Sensor Type	Accepted HART PV Unit	Abbreviation	HART PV Unit Code
P3 Pressure	Kilo Pascal	kPa	12

TABLE 6-5 Accepted PV unit for a P3 HART device

NOTE: The Secondary and Tertiary values of a P3 pressure HART device may be any units.

The PV of the P3 pressure HART device is read and converted into SI Units Pascals (Pa) within the FlexConn function PV.

The value is filtered, and the filtering factor depends on the value set in the entity [P3 Integration time]. A higher value gives more filtering, and a lower value gives less filtering.

The correction factor stored in the [P3 PV offset] entity is then subtracted from the filtered value. If the [P3 PV offset] entity = 0 no offset is applied.

Depending on the [PV selected type] entity, the P3 pressure can be displayed as either absolute pressure or relative pressure.

PV Unit Type	Display Unit Type	PV selected type
P3 Pressure	Absolute	1
	Relative	2

TABLE 6-6 P3 pressure displayed unit types

If Relative pressure is selected, the value stored in the [Ambient Air Pressure] entity is added to the measured pressure. If Absolute pressure is selected, no factor is added. The final result is available in the [Primary Value] entity.

NOTE: *Absolute pressure is used in the density calculation; the relative pressure is only displayed in P3* [Primary Value].

For the FCI-HT software to differentiate between a HART device malfunction and a HART device not actually installed, P3 pressure has the entity [P3 Installed] which must be set to either <Installed> if a P3 pressure HART device is actually fitted or <Not Installed> if a P3 pressure HART device is *not* actually fitted. For example, in the case of free-venting tanks, P3 would usually not be installed.

If the P3 pressure status is <Good Actual>, the P3 pressure value is also stored in memory in the [Last Valid P3] entity, to allow recovery from a power-down situation when a P3 pressure is not available.

If the measured P3 pressure is *invalid* (e.g. HART scan error), the software will check the [P3 Installed] entity to determine if P3 is actually fitted. If P3 is fitted, the software will check for a [Manual P3 Pressure] entity value to be entered. If no manual P3 pressure value is entered, the [Last Valid P3] is used in the density calculation. If no [Last Valid P3] is available, an error will be reported.

If P3 pressure is *not* installed - in the case of free-venting tanks - a default value of 0.0 for P3 pressure is used for density calculations.

The Secondary and Tertiary values of a P3 pressure HART device are not converted, and they are simply translated from the HART device to the FlexConn environment.

6.8.3.4 HIMS Density

To make HIMS density calculation possible, the relevant entity values must be available. See also FIGURE 6-31.

☛Read also the *Instruction Manual HIMS pressure measurement*.

Engauge SmartView

☛Enter the appropriate values into the following entities:

- [Distance P1 to Zero Level]
- [Distance P3 to Zero Level]
- [Hydrostatic Deformation Level]
- [Hydrostatic Deformation Factor]
- [Local Gravity]
- [Minimum HIMS Level]
- [HIMS Level Hysteresis]
- [Ambient Air Density]
- [Tank Vapour Density]

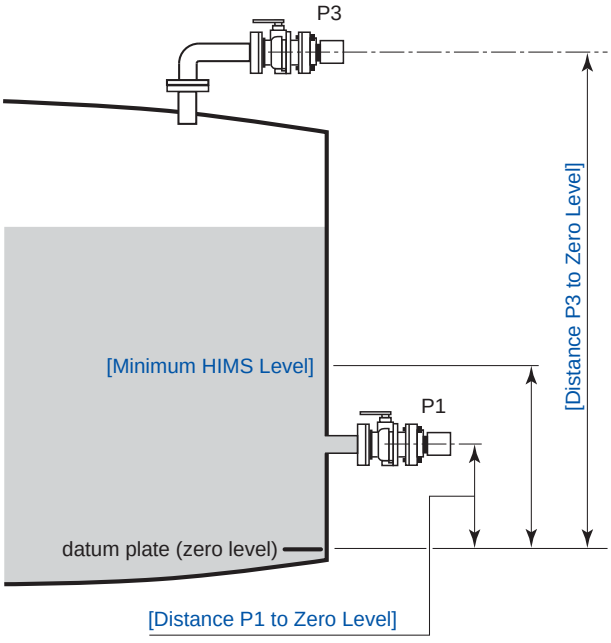


FIGURE 6-31 HIMS configuration principle

To calculate HIMS density, the following valid data must be available:

- P1 pressure
- P3 pressure
- Product level
- Water level (optional)

The software analyses the status of these 4 (3) inputs, to determine the value and status of the [HIMS Density PV].

If the HIMS Density PV status is <Good Actual>, the HIMS Density PV value is also stored in memory in the [Last Valid Density] entity, to allow recovery from a power-down situation when a HIMS Density PV value is not available.

If any of the 4 input statuses are bad, the software will check for a [Manual Product Density] entity value to be entered. If a [Manual Product Density] entity value is entered, this value will be used for the HIMS Density PV. If no [Manual Product Density] entity value is entered, the software will check if a [Last Valid Product Density] entity value was stored. If a [Last Valid Product Density] entity value was stored, this value will be used for the HIMS Density PV. If no [Manual Product Density] or [Last Valid Product Density] entity value is found, an error will be reported.

When calculating HIMS Density, the software will check for a negative density value. If the value is negative, the same manual or last-valid mechanism is used as described before. If the value is positive, HIMS Density is calculated.

When calculating HIMS Density, in order to achieve a valid result, the software will also check if the product level is above the [Minimum HIMS Level] entity value. If this condition is <True>, HIMS Density is calculated. If the product level is below the [Minimum HIMS Level] entity value, the same manual or last valid mechanism is used as described before.

When calculating HIMS Density, if the [Water Level Correction] entity is <Enabled>, the software will check if the scanned water level <= [Distance P1 to Zero Level]. If this is <True>, the HIMS Density is calculated. If the water level > [Distance P1 to Zero Level], the same manual or last valid mechanism is used as described before. If [Water Level Correction] entity is <Disabled>, the software will not check the scanned water level.

6.8.3.5 Generic HART Devices

The FCI-HT software only accepts Generic HART devices at addresses 0 and 4 through 15 with the required sensor type configured.

The generic HART devices are scanned sequentially from address 0 and then address 4 through 15. When a device is detected, initially the HART PV unit code is checked against TABLE 6-7 in the following order: Distance, Temperature, Pressure, and Density.

Sensor Type	Accepted HART Units	Abbreviation	HART Unit Code
Pressure	Pounds per square inch	psi	6
	Pascal	Pa	11
	Kilo Pascal	kPa	12

Sensor Type	Accepted HART Units	Abbreviation	HART Unit Code
Temperature	Degrees Celsius	°C	32
	Degrees Fahrenheit	°F	33
Distance	Feet	ft	44
	Meters	m	45
	Inches	in	47
Density	Kilograms per cubic meter	kg/m^3	92
	Pounds per cubic foot	lb/ft^3	94
	Degrees API	API	104

TABLE 6-7 Accepted units for generic HART devices

- If an accepted HART PV unit code is found, the HART device is allocated to the relevant FlexConn function as detailed in TABLE 6-8.
- If the HART PV unit code is *not* accepted, the HART SV unit code is checked against TABLE 6-7 in the following order: Distance, Temperature, Pressure, and Density. If an accepted HART SV unit code is found, the HART device is allocated to the relevant FlexConn function as detailed in TABLE 6-8.
- The process is repeated for the HART TV unit code.
- If none of the unit codes are accepted, the device is allocated to Function 7.

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☛If a generic HART device output is *not* in the accepted units, configure it to accepted units output data, by using the HART configuration tool.

FlexConn Function	Device Type
Function 1	[P1 Pressure]
Function 2	[P3 Pressure]
Function 3	[Distance]
Function 4	[Temperature]
Function 5	[Pressure]
Function 6	[Density]
Function 7	[Other]
Function 8	[HIMS Density]

TABLE 6-8 FlexConn function allocation

Once a device has been allocated to a function, the HART PV, SV, and TV are translated into the FlexConn function's PV, SV, and TV.

The required sensor value of the generic HART device may not be in the HART PV but it is translated into the FlexConn PV.

Example:

A HART temperature sensor may have a PV unit code Ohms, and a SV unit code Celsius. The required sensor value is temperature in Celsius, and this is translated into the FlexConn PV, and the Ohms value is translated into the FlexConn SV.

Translation is performed in the order: PV (Distance, Temperature, Pressure, and Density), SV (Distance, Temperature, Pressure, and Density), TV (Distance, Temperature, Pressure, and Density).

The required sensor value read from the generic HART devices will be converted into SI Units within the FlexConn PV as shown in TABLE 6-9.

The other sensor values of a generic HART device are not converted, and they are simply translated from the HART device environment into the FlexConn environment SV and TV.

Accepted HART Units	Abbreviation	FlexConn PV Unit Translation	Abbreviation
Pounds per square inch	psi	Pascal	Pa
Pascal	Pa		
Kilo Pascal	kPa		
Degrees Celsius	°C	Celsius	°C
Degrees Fahrenheit	°F		
Feet	ft	Meters	m
Meters	m		
Inches	in		
Kilograms per cubic meter	kg/m^3	Kilograms per cubic meter	kg/m^3
Pounds per cubic foot	lb/ft^3		
Degrees API	API		

TABLE 6-9 Generic HART device units into FlexConn PV unit translation

6.8.3.6 Function Identification

Functions 1 through 8 are identified by the entities: [Function Category], [Function Type], and [Function Sub-type].

Their default identification information is detailed in TABLE 6-10.

Function	Allocation	Function Category	Function Type	Function Sub-type
Function 1	P1 Pressure	Sensor (1)	Product pressure (5)	(6)
Function 2	P3 Pressure	Sensor (1)	Vapour pressure (13)	(7)
Function 3	Distance	Sensor (1)	HART transmitter (12)	(16)

Function	Allocation	Function Category	Function Type	Function Sub-type
Function 4	Temperature	Sensor (1)	HART transmitter (12)	(16)
Function 5	Pressure	Sensor (1)	HART transmitter (12)	(16)
Function 6	Density	Sensor (1)	HART transmitter (12)	(16)
Function 7	Other	Sensor (1)	HART transmitter (12)	(16)
Function 8	HIMS Density	Sensor (1)	Product density (6)	(8)

TABLE 6-10 Default function category, type, and sub-type

The function type entity for Functions 3 through 7 can be changed from the default value <HART transmitter> to provide more information about the sensor, by setting the [User function type] entity and then resetting the FCI-HT board.

The possible values are detailed in TABLE 6-11.

Function	Allocation	User Function Type	Value
Function 3	Distance	User function type product level	4
		User function type water level	9
Function 4	Temperature	User function type product temperature	8
		User function type vapour temperature	7
Function 5	Pressure	User function type product pressure	5
		User function type vapour pressure	13
Function 6	Density	User function type product density	6
Function 7	Other	User function type product level	4
		User function type water level	9
		User function type product temperature	8
		User function type vapour temperature	7
		User function type product pressure	5
		User function type vapour pressure	13
		User function type product density	6

TABLE 6-11 Generic HART user function types

Functions 1 through 8 have fixed values for [PV Unit Type] and [Function Identification] entities, as detailed in TABLE 6-12.

Function	Allocation	PV Unit Type	Function Identification
Function 1	P1 Pressure	UNIT_TYPE_PRESSURE	<P1 Pressure>
Function 2	P3 Pressure	UNIT_TYPE_PRESSURE	<P3 Pressure>
Function 3	Distance	UNIT_TYPE_LENGTH	<Distance>
Function 4	Temperature	UNIT_TYPE_TEMPERATURE	<Temperature>
Function 5	Pressure	UNIT_TYPE_PRESSURE	<Pressure>
Function 6	Density	UNIT_TYPE_DENSITY	<Density>
Function 7	Other	UNIT_TYPE_UNDEFINED	<Other Units>
Function 8	HIMS Density	UNIT_TYPE_DENSITY	<HIMS Density>

TABLE 6-12 PV unit type and function identification

6.8.3.7 SmartView Display

Although the Primary Values (PV) of functions 1 through 8 are *calculated* in SI units, the *SmartView display* supports the following units for local calibration, commissioning etc. The displayed unit depends on the value of the [PV selected unit] entity.

PV Unit Type	Display Unit Type	Displayed Units	PV Selected Unit	Range
Pressure	Pascal	<pas>	1	max. 0.99 MPa
	Kilo Pascal	<kpas>	2	max. 9.9 MPa
	Pounds per square inch (small)	<psi s>	3	max. 99 psi
	Pounds per square inch (large)	<psi l>	4	max. 999 psi
Temperature	Degrees Celsius	<°C>	1	-
	Degrees Fahrenheit	<°F>	2	-
Distance	Meters	<m>	1	-
	Feet	<ft>	2	-
	Inches	<in>	3	-
	Fractions (feet, inches, $1/16^{th}$ inch)	<f.i.s.>	4	-
Density	Kilograms per cubic meter	<kg/m3>	1	-
	Pounds per cubic foot	<lb/f3>	2	-
	Degrees API	<a.p.i>	3	-

PV Unit Type	Display Unit Type	Displayed Units	PV Selected Unit	Range
Other	Milli	<m ...>	1	-
	(none)	<->	2	-
	Kilo	<k ...>	3	-
	Mega	<M ...>	4	-

TABLE 6-13 *SmartView* displayed unit types

The following PV types are supported on the *SmartView* display for P1 pressure and P3 pressure only. These are available changed by setting the [PV selected type] entity. This is detailed in TABLE 6-14.

PV Unit Type	Display Unit Type	Displayed Type	PV selected type
P1 Pressure	Absolute	<ABS>	1
P3 Pressure	Relative	<REL>	2

TABLE 6-14 P1 and P3 pressure displayed unit types

6.8.4 Board Commissioning

The commissioning entity for each *function* is initially default to <False>. The commissioning entity for each function will only be <True> when the associated entities of each function have been set *within normal operating range*.

The *board-level* commissioned entity default is also <False>. It will only be <True> when all the function-level commissioned entities are <True>.

6.8.4.1 Function 1 Commissioning

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☛ Set all Function 1 entities according to TABLE 6-15 requirements, to commission P1.

HIMS Density	P1 Pressure Sensor Detected	P1 Ambient Air Pressure and P1 Installed	Commissioned
<Enabled>	N/A	[P1 ambient air pressure] ≠ <default> AND [P1 installed] = <enable>	<True>
		[P1 ambient air pressure] = <default> OR [P1 installed]= <disable>	<False>

HIMS Density	P1 Pressure Sensor Detected	P1 Ambient Air Pressure and P1 Installed	Commissioned
<Disabled>	Yes	[P1 ambient air pressure] ≠ <default> AND [P1 installed] = <enable>	<True>
		[P1 ambient air pressure] = <default> OR [P1 installed] = <disable>	<False>
	No	N/A	<True>

TABLE 6-15 Function 1 commissioning entities

6.8.4.2 Function 2 Commissioning

☛Set all Function 2 entities according to TABLE 6-16 requirements, to commission P3.

HIMS Density	P3 Pressure Sensor Detected	P3 Installed	P3 Ambient Air Pressure	Commissioned
<Enabled>	Yes	<Enable>	[P3 ambient air pressure] ≠ <default>	<True>
			[P3 ambient air pressure] = <default>	<False>
		<Disable>	N/A	<False>
	No	<Enable>	N/A	<False>
		<Disable>		<True>
<Disabled>	Yes	<Enable>	[P3 ambient air pressure] ≠ <default>	<True>
		<Disable>	[P3 ambient air pressure] ≠ <default>	<False>
		N/A	[P3 ambient air pressure] = <default>	<False>
	No	N/A	N/A	<True>

TABLE 6-16 Function 2 commissioning entities

6.8.4.3 Function 3 through 7 Commissioning

☛Set all Function 3 through 7 entities according to TABLE 6-17 requirements, to commission all generic HART sensors.

Function	HART Sensor Detected	User Function Type	Commissioned
3	Yes	= <Product level> OR <Water level>	<True>
		≠ <Product level> OR <Water level>	<False>
	No	N/A	<True>
4	Yes	= <Product temp.> OR <Vapour temp.>	<True>
		≠ <Product temp.> OR <Vapour temp.>	<False>
	No	N/A	<True>
5	N/A	N/A	<True>
6	N/A	N/A	<True>
7	N/A	N/A	<True>

TABLE 6-17 Function 3 through 7 commissioning entities

6.8.4.4 Function 8 Commissioning

☛Set Function 8 entities according to TABLE 6-18 requirements, to commission the HIMS density function.

HIMS Density	Function 8 Commissioning Entities	Commissioned
Enabled	<Hydrostatic deformation level> ≠ <Default> AND <Hydrostatic deformation factor> ≠ <Default> AND <Local gravity> ≠ <Default> AND <Minimum HIMS level> ≠ <Default> AND <Ambient air density> ≠ <Default> AND <Tank vapour density> ≠ <Default> AND <Distance P1 to zero level> ≠ <Default> AND <Distance P3 to zero level> ≠ <Default>	<True>
	<Hydrostatic deformation level> = <Default> OR <Hydrostatic deformation factor> = <Default> OR <Local gravity> = <Default> OR <Minimum HIMS level> = <Default> OR <Ambient air density> = <Default> OR <Tank vapour density> = <Default> OR <Distance P1 to zero level> = <Default> OR <Distance P3 to zero level> = <Default>	<False>
Disabled	N/A	<True>

TABLE 6-18 Function 8 commissioning entities

6.8.5 Hardware Configuration

6.8.5.1 Terminal Allocation

Terminal Number	Name	Function
24	V_Loop	HART Bus power
25	GND_Loop	HART Bus ground

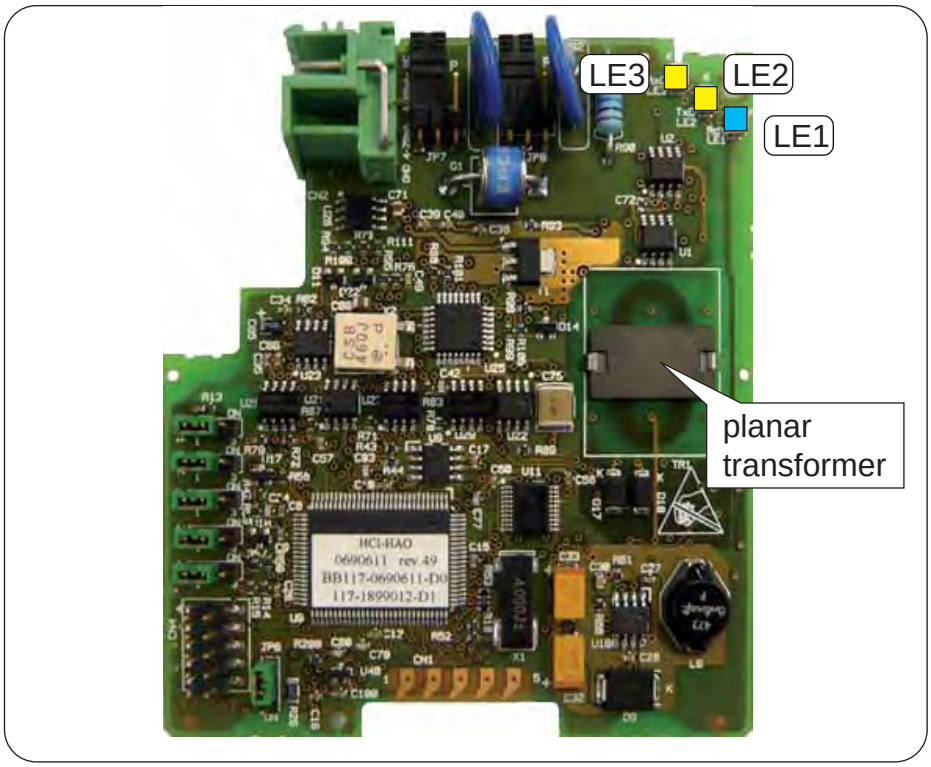
6.8.5.2 LED Allocation

LED Number	Function
LE2	HART data Transmit
LE3	HART data Receive

6.9 HART Analog Outputs (HCI-HAO)

6.9.1 Introduction

The Host Communication Interface – HART Analog Output (HCI-HAO) is a HART® slave module which communicates with the associated HART master over the HART bus.



ESF09-0005

FIGURE 6-32 The HCI-HAO board

The HART protocol is a bi-directional master-slave communication protocol, which is used to communicate between intelligent field instruments and host systems.

The HCI-HAO board has a planar transformer for galvanic isolation from the HART bus. See FIGURE 6-32.

LED LE1 is the board's [Health] LED. LEDs LE2 and LE3 will be flashing to indicate activity on the HART bus. LE2 indicates data is being transmitted (Tx), LE3 indicates data is being received (Rx).

6.9.2 Functional Description

HCI-HAO is a HART slave module, which uses standard HART communication to communicate with HART-devices. This module makes use of the Bell 202 Frequency Shift Keying (FSK) standard to superimpose digital signals at a low level on the 4–20 mA analog signal.

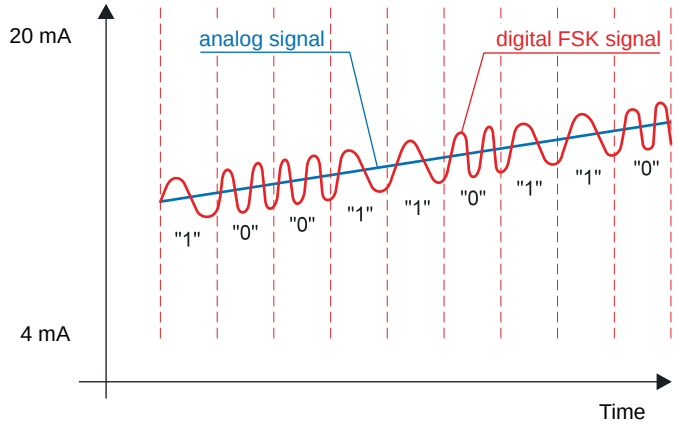


FIGURE 6-33 The analog and digital signals within the HART® communication ESF07-0015

The HCI-HAO works as an interface board between FlexConn boards and a HART master, and it makes the data available on the HART bus.

The user needs *to set the required linked variable details*.

The linked primary variable is mapped between 4–20 mA on the analog output depending on the range values set. The linked variables are scanned every 1 second and so is the analog output refresh rate.

The HCI-HAO is configurable by:

- a HART communicator
- a local SmartView
- Engauge

The HCI-HAO (board ID = 11) has following two functions:

Function	Category	Type	Sub-type
1 - HART communication	Communication	Instrument slave	HART
2 - Analog output	Sensor	Analog output	4 - 20 mA

All the HART *universal commands* and some *common practice commands* are supported by HCI-HAO. These are listed in the below tables.

HART Universal Ccommands	
Command no.	**Description**
0	Read Unique Identifier
1	Read Primary Variable
2	Read Loop Current and Percentage of Range
3	Read Dynamic variables and Loop Current
4	Reserved
5	Reserved
6	Write Polling Address
7	Read Loop Configuration
8	Read Dynamic Variable Classifications
9	Read Device Variable With Status
10	Reserved
11	Read Unique Identifier Associated with Tag
12	Read Message
13	Read Tag, Descriptor, Date
14	Read PV Sensor Information
15	Read Device Information
16	Read Final Assembly Number
17	Write Message
18	Write Tag, Descriptor, Date
19	Write Final Assembly Number
20	Read Long Tag
21	Read Unique Identifier Associated With Long Tag
22	Write Long Tag

HART Common Practice Commands	
Command no.	**Description**
34	Write Primary Variable Damping Value
35	Write Primary Variable Range Values
36	Set Primary Variable Upper Range Value
37	Set Primary Variable Lower Range Value
38	Reset Configuration Changed Flags
40	Enter / Exit Fixed Current Mode
41	Perform Self Test
42	Perform Device Reset
44	Write Primary Variable Units
48	Read Additional Device Status
50	Read Dynamic Variable Assignments
51	Write Dynamic Variable Assignments
53	Write Device Variable Units
54	Read Device Variable Information
55	Write Device Variable Damping Value
59	Write Number Of Response Preambles
72	Squawk
79	Write Device Variable
113	Catch Device Variable

6.9.3 Other HCI-HAO features

- *Planar transformer* for galvanic isolation from HART bus.
- *Malfunctioning* of the HCI-HAO card (or any linked cards) is reveiled on the HART bus by means of the *device status*.
- If any *fatal errors* occur during operation - which will run the program into an undesired situation - then a software reset (Warm Reset) is given to the HCI-HAO software. During this situation, the output of the module remains at the desired level till the software starts normal working. Handling of a fatal error is a general FlexConn function. This will update the appropriate entity as well.
- *Unit conversions* for the linked variables are possible. All the linked variables available through linking (data read from other FlexConn boards) are in SI units. Accepted units are listed in the table below.

Sensor Type	Accepted HART Units	Abbreviation	HART Unit Code
Temperature	Degrees Celsius	°C	32
	Degrees Fahrenheit	°F	33
Pressure	Pounds per square inch	psi	6
	Pascal	Pa	11
	Kilo Pascal	kPa	12
Level	Feet	ft	44
	Meters	m	45
	Inches	in	47
Density	Kilograms per cubic meter	kg/m^3	92
	Pounds per cubic foot	lb/ft^3	94
	Degrees API	API	104

- *Analog output read back* mechanism, which is used to indicate any errors in the analog output section. An error can be indicated using the control relay on the FII-DO module over the CAN bus. If some error is found in the DAC read back, then the same is updated in function 2 (sensor) health, as per following details in status and status codes:

Status	<BAD>
Status Category	<GENERAL_HARDWARE_FAIL>
Status Code	<DAC_READ-BACK_FAIL>

- *Active and Passive mode* of operation for Loop current.
- *Multi-drop mode* supported to connect more than one HART-compatible device on HART bus. For operating the device in Multi-Drop mode, user needs to select the polling address to a non-zero value. Making the polling address to a non-zero value makes the output current mode to Fixed_4_20_MA (4 mA fixed). Non-zero polling address will automatically make the output current mode to Fixed_4_20_MA.

All the HART-compatible devices connected over the HART bus must have different polling addresses. *Multi-drop mode is supported only in Passive mode of loop configuration*. When the output current mode is set to Standard_4_20_MA, the polling address of the device must be made zero.

- When the device is *not* in multi-drop mode (STANDARD_4_20_MA mode selected) then the output current follows the changes in linked PV value.
- *Scanning of each linked available PV, SV, TV and QV on the CAN-bus with frequency of 1 Hz.* That means all the available linked variables are scanned every 1 second.
- The *analog output is refreshed every 1 second*, even if there is no change in the scanned variables. So, the watchdog for analog output is automatically implemented. If the output is not refreshed within 45 seconds then a watchdog to analog output is generated and the output is forced to 0 mA.
- *During startup, the analog output* of the HCI-HAO module is *kept low (< 0.5 mA)*. This value will be there till initialization takes place. Once the normal operation starts the output will follow the linked PV depending upon the output mode setting.
- *Manual overwrite mechanism*. This is a standard FlexConn functionality. Separate configuration and command entities are defined for this. See 6.9.5 - Board Commissioning.

6.9.4 Calibration of the HCI-HAO

A calibration provision is given, which is used to accurately map the analog output between 4 -20 mA using the two range values entered for Primary Variable.

Following table lists all entities required for calibration.

Entity	Data Type	Type
[Analog Output at 4 mA]	Float	non-volatile R/W
[Analog Output at 18 mA]	Float	non-volatile R/W
[Calibrate at 4 mA]	Undefined	command
[Calibrate at 18 mA]	Undefined	command
[Enter Calibration Mode]	Undefined	command
[Exit Calibration Mode]	Undefined	command

NOTE: Commands used in the following calibration procedure can be executed either by using the CAN tool, the SmartView, or Engauge.

Calibrate the analog output of the HCI-HAO as follows:

☛Connect loop resistor at connector CN2

☛Power up HCI-HAO board

☛Give command [Enter Calibration Mode]

☛Give command [Calibrate Analog Output at 4mA]

☛Measure actual output current through the loop resistor, using a current meter

☛Enter this value in the [Analog Output at 4mA] entity

☛Give command [Calibrate Analog Output at 18mA]

☛Measure actual output current through the loop resistor, using a current meter

☛Enter this value in the [Analog Output at 18mA] entity

☛Give command [Exit Calibration Mode], to exit the calibration mode

These calibration data are used to calculate the analog output current for the Primary Value (PV).

Untill calibration has been carried out, the Health status of the PV and the analog output function will be:

Status	<BAD>
Status Category	<STATUS_CATEGORY_BAD_GENERAL_CALIBRATION_FAIL>
Status Code	<CALIBRATION_SET_POINTS_NOT_CALIBRATED>

6.9.5 Board Commissioning

6.9.5.1 Basic Configurable Entities Overview

Basic configuration entities of the HCI-HAO board, which are configurable by using *SmartView*, are listed in the following table.

Entity	SmartView Display	Data Type	Type	Default	Function
[PV Link board ID]	PV linked Brd ID	Unsigned int 8 bits	Non-Volatile	<0>	Board Specific
[PV Link board instance]	PV linked Brd IN	Unsigned int 8 bits	Non-Volatile	<0>	
[PV Link function instance]	PV linked Brd FI	Unsigned int 8 bits	Non-Volatile	<0>	
[PV Link Board Sensor Value]	PV link Brd SVAL	Enumeration	Non-Volatile	<PV_LINK>	
[SV Link board ID]	SV linked Brd ID	Unsigned int 8 bits	Non-Volatile	<0>	
[SV Link board instance]	SV linked Brd IN	Unsigned int 8 bits	Non-Volatile	<0>	
[SV Link function instance]	SV linked Brd FI	Unsigned int 8 bits	Non-Volatile	<0>	
[Polling Address]	Polling Address	Unsigned int 8 bits	Non-Volatile	<0>	Communication
[HART PV unit code]	PV Unit Code	Enumeration	Non-Volatile	<UNKNOWN>	
[Upper Transducer Limit]	Upper Tran Limit	Float	Non-Volatile	<0>	
[Lower Transducer Limit]	Lower Tran Limit	Float	Non-Volatile	<0>	
[Transducer Serial Number]	Transducer Sr No	Unsigned int 32 bits	Non-Volatile	<123>	

Entity	SmartView Display	Data Type	Type	Default	Function
[PV Lower range value]	Lw Range Value	Float	Non-Volatile	<0>	Sensor (Analog Output)
[PV Upper range value]	Up Range Value	Float	Non-Volatile	<0>	
[Analog Output mode]	HART Mode	Enumeration <Fixed 4-20mA> <Standard 4-20mA>	Non-Volatile	<Standard 4-20mA>	
[Burnout Value]	Burnout Value	Float	Non-Volatile	<3.6>	
[Burnout Behavior]	Burnout Behavior	Enumeration <BAD> <UNCERTAIN> <BAD + UNCERTAIN>	Non-Volatile	<BAD>	
[Enter Calibration Mode]	Enter Cal Mode	Undefined	Command		
[Cal Value at 4 mA]	Cal Value at 4 mA	Float	Non-Volatile	<0>	
[Cal Value at 18 mA]	Cal Value at 18 mA	Float	Non-Volatile	<0>	
[Calibrate at 4 mA]	Calibrate at 4 mA	Undefined	Command		
[Calibrate at 18 mA]	Calibrate at 18 mA	Undefined	Command		
[Exit Calibration Mode]	Exit Cal Mode	Undefined	Command		

6.9.5.2 Commissioning

☛The following entities ***must*** be set by *Engauge* or *SmartView* for a correct functioning of the HCI-HAO module in an instrument.

Name	Explanation	Default Value	Function Part	Function
[PV Link board ID]	Board ID of Other FlexConn to be linked as PV to HCI-HAO	<0>	Board	Board Specific
[PV Link board instance]	Board Instance of the linked PV board	<0>		
[PV Link function instance]	Function Instance of the linked PV board	<0>		
[PV Link Sensor Value]*	Primary or secondary variable of linked card can be assigned to this	<PV_LINK>		

Name	Explanation	Default Value	Function Part	Function
[HART PV unit code]	Unit code for linked PV	<UNIT_CODE_UNKNOWN>	Function 1	Communication (HART communication)
[HART Upper Transducer Limit]	Upper transducer limit for connected sensor of linked PV board	<0>		
[HART Lower Transducer Limit]	Lower transducer limit for connected sensor of linked PV board	<0>		
[Polling Address]	Polling address of the device, which is used for poll-based addressing	<0>		
[Transducer Serial Number]	Transducer serial number of connected sensor of linked PV board	<123>		
[Upper Range Value]	Upper range value for PV. This value is used to calculate the analog output current.	<0>	Function 2	Sensor (Analog Output)
[Analog Output at 4mA]	Calibration reading when [Calibrate at 4 mA] command is given	<0>		
[Analog Output at 18 mA]	Calibration reading when [Calibrate at 18 mA] command is given	<0>		
[Lower Range Value]	Lower range value for PV. This value is used to calculate the analog output current.	<0>		
[Analog Burnout Value]	Analog burnout value in case of malfunctioning device	<3.6mA>		

*) Default values for entities marked in GREEN in the above table could be considered as proper values for making the health for respective Function or Board <GOOD>. However, the user is free to choose these values as per the requirement along with the rest of the entities.

All the entities in the above table would be initialized to their *default* values after [init novram] command is given. All the entities should have their proper values so as to make the respective Function and Board health to <GOOD> status.
The [Analog Output at 4 mA] and [Analog Output at 18 mA] fields should be entered after giving proper calibration commands (for more details, see 6.9.4).

☛The following entities ***can*** be set by *Engauge* or *SmartView* for a correct functioning of the HCI-HAO module in an instrument.

If one needs to assign SV, TV, QV to HCI-HAO then the corresponding unit codes also needs to be set properly so that the value read from other FlexConn board will be proper.

Name	Explanation	Default Value	Function Part	Function
[SV Link board ID]	Board ID of Other FlexConn which is linked as SV to HCI-HAO	<0>	Board	Board Specific
[SV Link board instance]	Board Instance of the linked SV board	<0>		
[SV Link function instance]	Function Instance of the linked SV board	<0>		
[TV Link board ID]	Board ID of Other FlexConn which is linked as TV to HCI-HAO	<0>		
[TV Link board instance]	Board Instance of the linked TV board	<0>		
[TV Link function instance]	Function Instance of the linked TV board	<0>		
[QV Link board ID]	Board ID of Other FlexConn which is linked as QV to HCI-HAO	<0>		
[QV Link board instance]	Board Instance of the linked QV board	<0>		
[QV Link function instance]	Function Instance of the linked QV board	<0>		
[Linked Primary Value]	PV / SV value of linked PV board in the set unit code	<0>		
[Linked Secondary Value]	PV value of linked SV board in the set unit code	<0>		
[Linked Tertiary Value]	PV value of linked TV board in the set unit code	<0>		
[Linked Quarternary Value]	PV value of linked QV board in the set unit code	<0>		

Name	Explanation	Default Value	Function Part	Function
[HART SV unit code]	Unit code for linked SV	<UNIT_CODE_UNKNOWN>	Function 1	Communication (HART communication)
[HART TV unit code]	Unit code for linked TV	<UNIT_CODE_UNKNOWN>		
[HART QV unit code]	Unit code for linked QV	<UNIT_CODE_UNKNOWN>		
[Configuration changed Counter]	Increments every time the configuration is changed	<0>		
[Device ID]	Same as Enraf Serial number. This is a unique number to every board.			
[Device Type]	Device type registered with the HART Communication Foundation	<127>		
[Manufacturer ID Number]	Manufacturer ID registered with the HART Communication Foundation	<148>		
[Number of Preambles]	Number of preambles required for a request from the HART master	<7>		
[Number of Response Preambles]	Number of preambles in the HCI-HAO response stream	<7>		
[Fixed Current Value]	Fixed analog output current set by HART command 40	<0>	Function 2	Sensor (Analog Output)
[Loop Current Mode]	If HART mode selected is <Standard 4-20mA>, then it is enabled. If HART mode selected is <Fixed 4-20mA>, then it is disabled.	<Enabled>		
[Percentage of Range]	Percentage of current PV with respect to the limits set	<0>		

6.9.6 Hardware Configuration

6.9.6.1 Jumper Allocation

The following are typical jumper settings done on the HCI-HAO board.

Jumper Number	Position	Connection Details	Description	Default Position	Default Connections
JP1	ON	Short 2 & 3	W&M Entity Protection	OFF	Short 1 & 2
JP2	ON	Short 2 & 3	Password Read Protection	OFF	Short 1 & 2
JP3	ON	Short 2 & 3	Write Protection All Entities	OFF	Short 1 & 2
JP4	ON	Short 2 & 3	Free	OFF	Short 1 & 2
JP5	ON	Short 2 & 3	Free	OFF	Short 1 & 2
JP6	ON	Short 2 & 3	CAN termination 120E resistor	OFF	Short 1 & 2
JP7 & JP8	A	Short 1 & 2	Active mode for Analog Output	A	Short 1 & 2
JP7 & JP8	P	Short 2 & 3	Passive mode for Analog Output		

6.9.6.2 Terminal Allocation

t.b.d.

6.9.6.3 LED Allocation

LED Number	Function
LE2	HART data Transmit
LE3	HART data Receive

6.10 Average Temperature & Water Level Measurement (FII-VT)

6.10.1 Introduction

The Field Interface Instrument - VITO[1] (FII-VT) board is a VITO-data processor module, which calculates average product- and vapour temperatures, and optionally a water level.

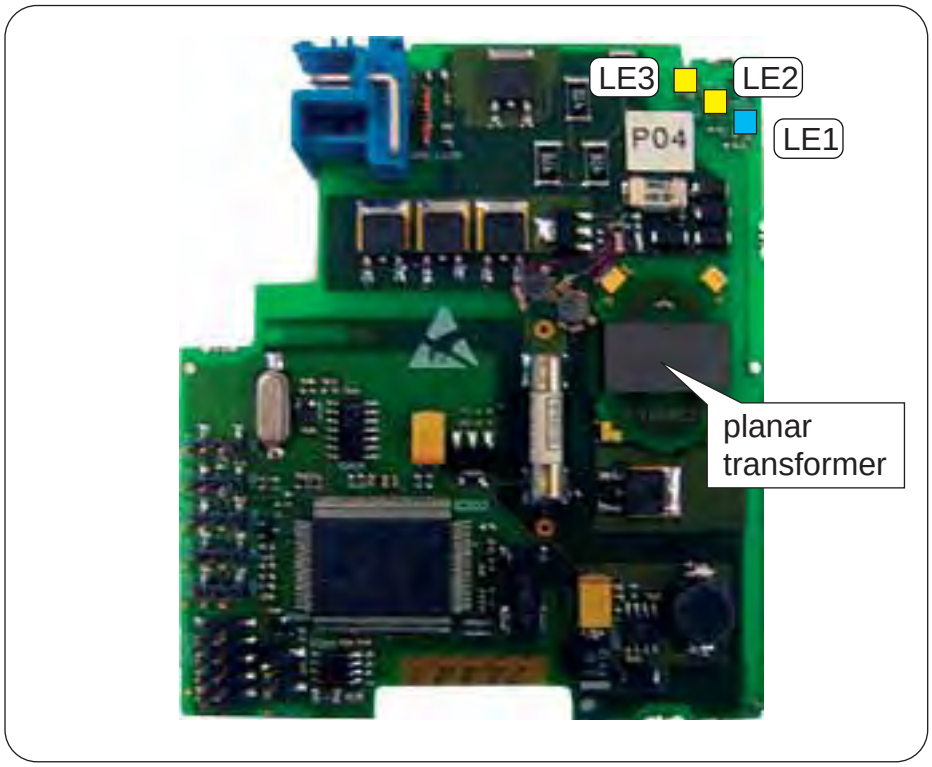


FIGURE 6-34 The FII-VT board with its planar transformer ESF07-0016

By using the HART® protocol (see also 6.8.1), the FII-VT module can be connected to one VITO-interface which in turn is connected to a probe for *product temperature*, *vapour temperature*, *water level*, or a combination of these.

The FII-VT board has a planar transformer for galvanic isolation from the HART bus. See FIGURE 6-34.

LED LE1 is the board's [Health] LED. LEDs LE2 and LE3 will be flashing to indicate activity on the HART bus. LE2 indicates data is being transmitted (Tx), LE3 indicates data is being received (Rx).

1. Versatile In-Tank Observer

6.10.2 VITO Interface Types

For temperature and/or water level measurement, a proper VITO probe must be connected to the FII-VT module, using a VITO interface.

There are 3 VITO interface types:

- 762 VITO MTT interface for 16-spot temperature measurement (*thermocouple principle*) and optionally a water bottom measurement
- 762 VITO LT interface for 9-spot temperature measurement (*thermocouple principle*) and optionally a water bottom measurement
- 762 VITO MRT interface for Multiple Resistance Thermometer and multi-spot (*resistance variation principle*) measurement

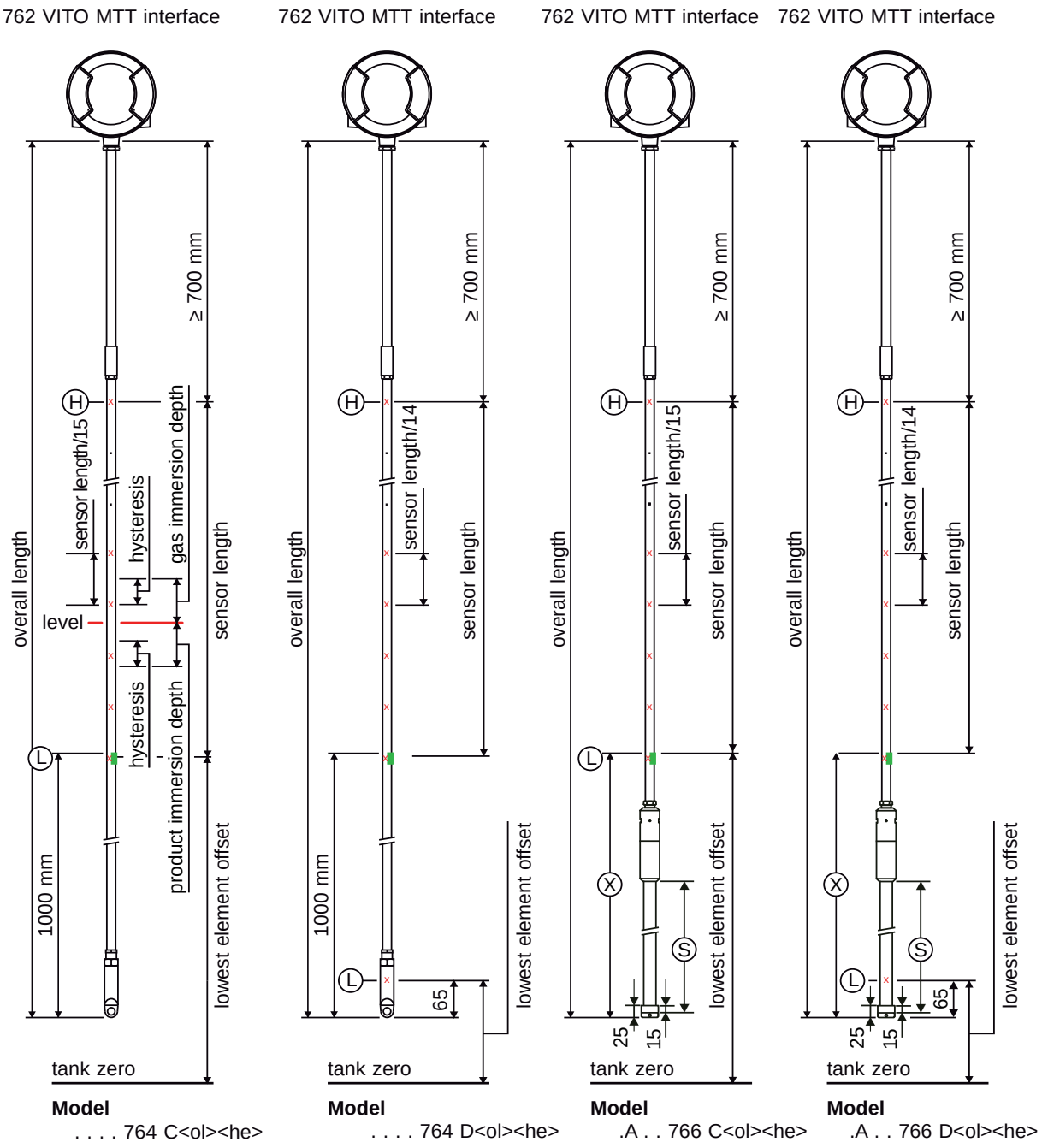
6.10.3 Commissioning

6.10.3.1 Commissioning Parameters for MTT/LT Probes

The following 9 configurations are possible:

Enraf Model	VITO Type	Description
764C	MTT Temperature probe	lowest spot next to Pt100, no water probe
764D		lowest spot below Pt100, no water probe
766C	MTT Combi probe	lowest spot next to Pt100, combined with water probe
766D		lowest spot below Pt100, combined with water probe
767C	LT Temperature probe	lowest spot next to Pt100, no water probe
767D		lowest spot below Pt100, no water probe
768C	LT Combi probe	lowest spot next to Pt100, combined with water probe
768D		lowest spot below Pt100, combined with water probe
765	Water probe	water probe only

These models are depicted in FIGURE 6-35 and FIGURE 6-36.



Pt 100 reference resistor
X Thermocouple (spot)

(H) Highest spot
(L) Lowest spot

(S) Sensitive length = 0.5 / 1.0 / 1.5 / 2.0 m
(X) Depending on actual Sensitive length, this length = 1.0 / 1.5 / 2.0 / 2.5 m

FIGURE 6-35 Tank and temperature probe data (1)

ESF07-0017

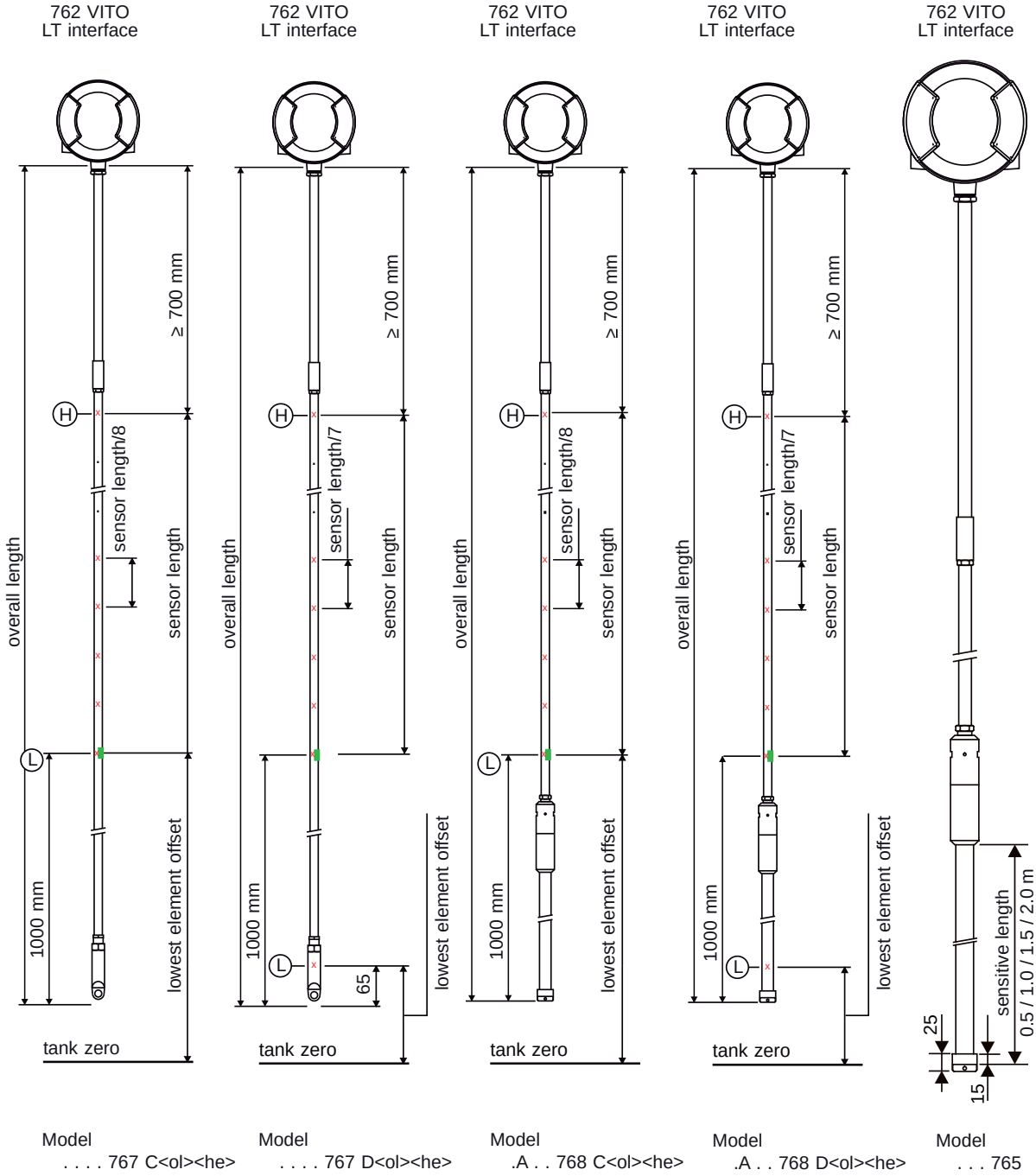


FIGURE 6-36 Tank and temperature probe data (2)

ESF07-0018

6.10.3.1.1 Product Temperature

☛The following entities ***must*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

*NOTE: Using Engauge, following entities are set within the Engauge **Product temperature** tab.*

Name	Explanation	Value Range	Default
[Lowest element offset]	The distance from tank zero till the lowest element position in the temperature probe	floating point number: <-x.x .. +x.x>	<80.0>
[Sensor length]	The distance from the Pt100 position till the highest element position	floating point number: <-x.x .. +x.x>	<80.0>

The following entities ***can*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

☛Check each entity for its correctness.

Name	Explanation	Value Range	Default
[Product immersion depth]	The minimum required distance of the product level above an element before it is taken into account in the average product temperature calculation	floating point number: <-x.x .. +x.x>	<0.5>
[Hysteresis]	The distance for a hysteresis mechanism around the switching point of the elements that are taken into account in the calculation	floating point number: <-x.x .. +x.x>	<0.1>
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm] 	4 thresholds for activating a related alarm status in the Primary Value	floating point number: <-x.x .. +x.x>	<+1.0E22>

Name	Explanation	Value Range	Default
[Alarm test enable]	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Element wiring]	Used for excluding an element from the average product temperature calculation.	16 characters A non-zero (≠ 0) character at position **x** results in element **x** being excluded from calculation.	<0000000000000000>
[Function identification]	The current module's function name. This function is visible on the *SmartView* display.	13 characters	<Product temp.>

6.10.3.1.2 Vapour Temperature

*NOTE: Using Engauge, following entities are set within the Engauge **Vapour temperature** tab.*
Some Vapour temperature settings are shared with Product temperature settings.

The following entities ***can*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

☛Check each entity for its correctness.

Name	Explanation	Value Range	Default
[Gas immersion depth]	The minimum required distance below an element before it is taken into account in the average vapour temperature calculation	floating point number: <-x.x .. +x.x>	<0.5>
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	4 thresholds for activating a related alarm status in the Primary Value	floating point number: <-x.x .. +x.x>	<+1.0E22>

Name	Explanation	Value Range	Default
[Alarm test enable]	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Function identification]	The current module's function name. This function is visible on the *SmartView* display.	13 characters	<Vapour temp.>

6.10.3.1.3 Water Level (for 766/768 Combi probes and 765 Water probe only)

☛The following entities ***must*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

Name	Explanation	Value Range	Default
[Maximum water capacity]	The maximum capacity when the probe is fully submerged in water (in pF)	floating point number: <-x.x .. +x.x>	<20000>
[Minimum water capacity]	The minimum capacity when the probe is not submerged in water (in pF)	floating point number: <-x.x .. +x.x>	<20000>
[Water probe bottom position]	The offset to the water probe zero point in relation with the tank zero point	floating point number: <-x.x .. +x.x>	<80>
[Upper reference level]	The distance from tank zero point to upper reference point; is used for water ullage calculation	floating point number: <-x.x .. +x.x>	<80>

☛The following entities ***can*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

Name	Explanation	Value Range	Default
[Water probe length]	The length of a water probe	floating point number: <-x.x .. +x.x>	<0.5>
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	4 thresholds for activating a related alarm status in the Primary Value	floating point numbers: <-x.x .. +x.x>	<+1.0E22>
[Alarm test enable]	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Function identification]	The current module's function name. This function is visible on the *SmartView* display.	13 characters	<Water level>

6.10.3.2 Commissioning Parameters for MRT or RTD

Enraf Model	VITO Type	Description
MRT	Multiple Resistance Thermometer	MRT with up to 13 temperature elements with one spot element
RTD	3-spot Resistance Temperature Detector	1..3 RTD spots in a 3-wire connection
	multi-spot Resistance Temperature Detector	1..14 RTD spots in a 2-wire connection

See FIGURE 6-37 and FIGURE 6-38.

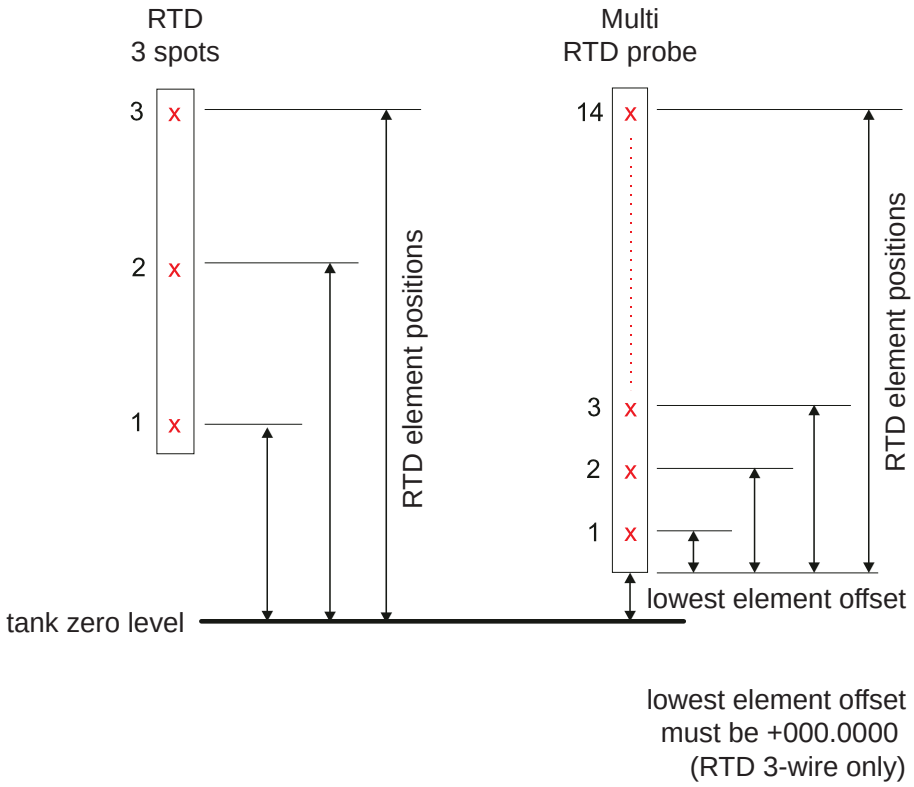


FIGURE 6-37 Resistance Temperature Detector (RTD) elements positions ESF07-0020

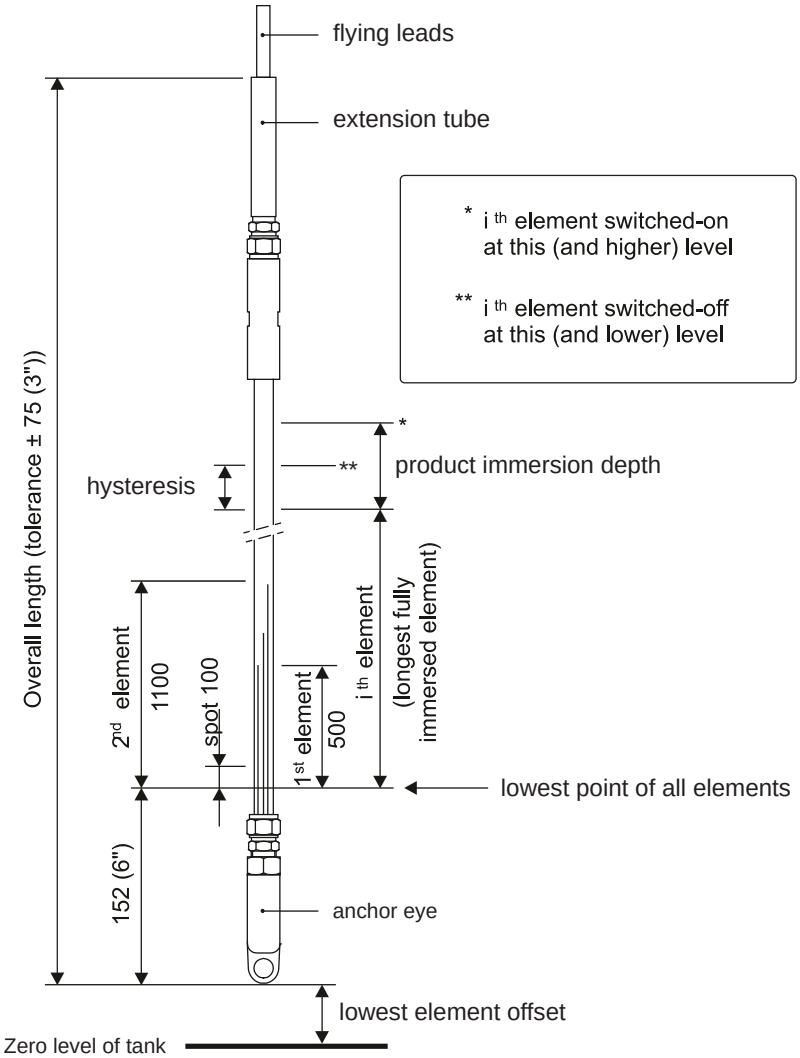


FIGURE 6-38 Multiple Resistance Thermometer (MRT) parameters ESF07-0019

6.10.3.2.1 *Product Temperature*

Engauge / SmartView

☛The following entities ***must*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

NOTE: Using Engauge, following entities are set within the Engauge ***Product temperature*** *tab.*

■ RTD 3 spots (see FIGURE 6-37 *left* side)

Name	Explanation	Value Range	Default
[Element type]	The supported element type is: SPL	3 characters <SPL>	<--->
[Number of elements]	The number of elements a RTD probe has	<1 .. 3>	<0>
[Lowest element offset]	The distance from tank zero till the lowest position of the multi-RTD probe. So **not** used for the 3-wire version and it must be 0.	floating point number: <-x.x .. +x.x> MUST BE <0.0>	<80.0>
[RTD element positions]	The positions of the RTDs from tank zero level	3 floating point numbers: <-x.x .. +x.x> Note: Only *actually used* elements to be entered.	<0,0,0>

■ Multi RTD probe (see FIGURE 6-37 *right* side)

Name	Explanation	Value Range	Default
[Element type]	The supported element type is : SPL	3 characters <SPL>	<--->
[Number of elements]	The number of elements a RTD probe has	<1 .. 14>	<0>
[Lowest element offset]	The distance from tank zero till the lowest position of the multi-RTD probe	floating point number: <-x.x .. +x.x>	<80.0>
[RTD element positions]	The positions of the RTDs from the lowest position of the probe. So **not** tank zero level!	14 floating point numbers: <-x.x .. +x.x> Note: Only *actually used* elements to be entered.	<0,0,0,0,0,0,0,0,0,0,0,0,0,0>

■ MRT (see FIGURE 6-38)

Name	Explanation	Value Range	Default
[Element type]	See Table TABLE 6-19 below.	3 characters <RCB> <RCN> <RCS> <QCB> <QCN> <QCS>	<--->
[Number of elements]	The number of elements (resistors) an MRT probe has	<1 .. 14>	<0>
[Lowest element offset]	The distance from tank zero till the lowest position of the MRT probe	floating point number: <-x.x .. +x.x>	<80.0>
[MRT element length] if MRT length table = <T>	The lengths of the MRTs including anchor eye	14 floating point numbers: <-x.x .. +x.x>	<0,0,0,0,0,0,0,0,0,0,0,0,0,0>
[MRT length table]	Specifies whether a fixed range of MRT resistors is used (= <F>) or user-configured lengths (= <T>). Fixed lengths are: 0.25 / 0.65 / 1.25 / 1.95 / 2.85 / 4.15 / 5.65 / 7.35 / 9.25 / 11.65 / 14.65 / 18.45 / 22.95 / 29.65	1 character <F> <T>	<F>

R..	= an MRT *without* spot element
Q..	= an MRT *with* spot element
.CB	Rth = 90.2935 + T x 0.38826 (- 100 through + 280 °C)
.CN	Rth = 90.4778 + T x 0.38090 (- 100 through + 280 °C)
.CS	Rth = 90.5000 + T x 0.38730 (- 100 through + 280 °C)

TABLE 6-19 Element type definitions

The following entities ***can*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

☛Check each entity for its correctness.

Name	Explanation	Value Range	Default
[Product immersion depth]	The minimum required product level distance above an element before this element is taken into account in the average product temperature calculation	floating point number: <-x.x .. +x.x>	<0.5>
[Hysteresis]	This is a hysteresis mechanism distance around the switching points of the elements that are taken into account in the calculation.	floating point number: <-x.x .. +x.x>	<0.1>
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm] 	4 thresholds for activating a related alarm status in the Primary Value	floating point numbers: <-x.x .. +x.x>	<1.0E22>
[Alarm test enable] 	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>
[Alarm test] 	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Function identification] 	The current module's function name. This function is visible on the *SmartView* display.	13 characters	<Product temp.>

6.10.3.2.2 Vapour Temperature

*NOTE: Using Engauge, following entities are set within the Engauge **Vapour temperature** tab.*
Some Vapour temperature settings are shared with Product temperature settings.

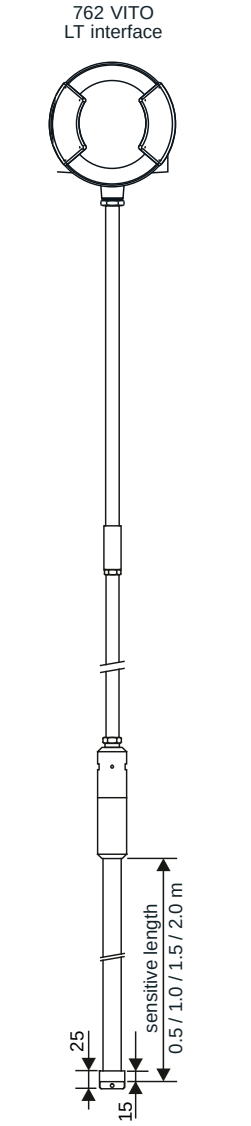
The following entities ***can*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

☛Check each entity for its correctness.

Name	Explanation	Value Range	Default
[Gas immersion depth]	The minimum required distance below an element before it is taken into account in the average vapour temperature calculation	floating point number: <-x.x .. +x.x>	<0.5>
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	4 thresholds for activating a related alarm status in the Primary Value	floating point numbers: <-x.x .. +x.x>	<+1.0E22>
[Alarm test enable]	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Function identification]	The current module's function name. This function is visible on the *SmartView* display.	13 characters	<Vapour temp.>

6.10.3.3 Commissioning Parameters for the 765 VITO Water Probe

For the entities to be set for the stand-alone 765 VITO water probe (see FIGURE 6-39), see 6.10.3.3.1.



Model 765 VITO water probe

FIGURE 6-39 The model 765 VITO water probe

ESF07-0042

6.10.3.3.1 Water Level

☛The following entities ***must*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

Name	Explanation	Value Range	Default
[Maximum water capacity]	The maximum capacity when the probe is fully submerged in water (in pF)	floating point number: <-x.x .. +x.x>	<20000>
[Minimum water capacity]	The minimum capacity when the probe is not submerged in water (in pF)	floating point number: <-x.x .. +x.x>	<20000>
[Water probe bottom position]	The offset to the water probe zero point in relation with the tank zero point	floating point number: <-x.x .. +x.x>	<80>
[Upper reference level]	The distance from tank zero point to upper reference point; is used for water ullage calculation	floating point number: <-x.x .. +x.x>	<80>

☛The following entities ***can*** be set by *Engauge* or *SmartView* for a correct functioning of the FII-VT module in an instrument.

Name	Explanation	Value Range	Default
[Water probe length]	The length of the 765 VITO water probe	floating point number: <-x.x .. +x.x>	<0.5>
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	4 thresholds for activating a related alarm status in the Primary Value	floating point numbers: <-x.x .. +x.x>	<+1.0E22>
[Alarm test enable]	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>

Name	Explanation	Value Range	Default
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Function identification]	The current module's function name. This function is visible on the *SmartView* display.	13 characters	<Water level>

6.10.4 Commissioning Check

☛ After having checked/set all before listed entities, make sure

- the [Board Commissioned], the [Product temperature Commissioned], the [Vapour temperature Commissioned], and - if applicable - the [Water level Commissioned] entities are <True>;
- the [Board Health], the [Product temperature Health], the [Vapour temperature Health], and - if applicable - the [Water level Health] entities are <GOOD>.

6.11 Average Temperature Measurement (FII-RTD)

6.11.1 Introduction

The Field Interface Instrument - Resistance Temperature Detector (FII-RTD) board is a sensor module for the instrument (gauge) and calculates average product- , vapour- and ambient temperatures.

For realizing this, RTDs or MRTs must be directly connected to the FII-RTD module.

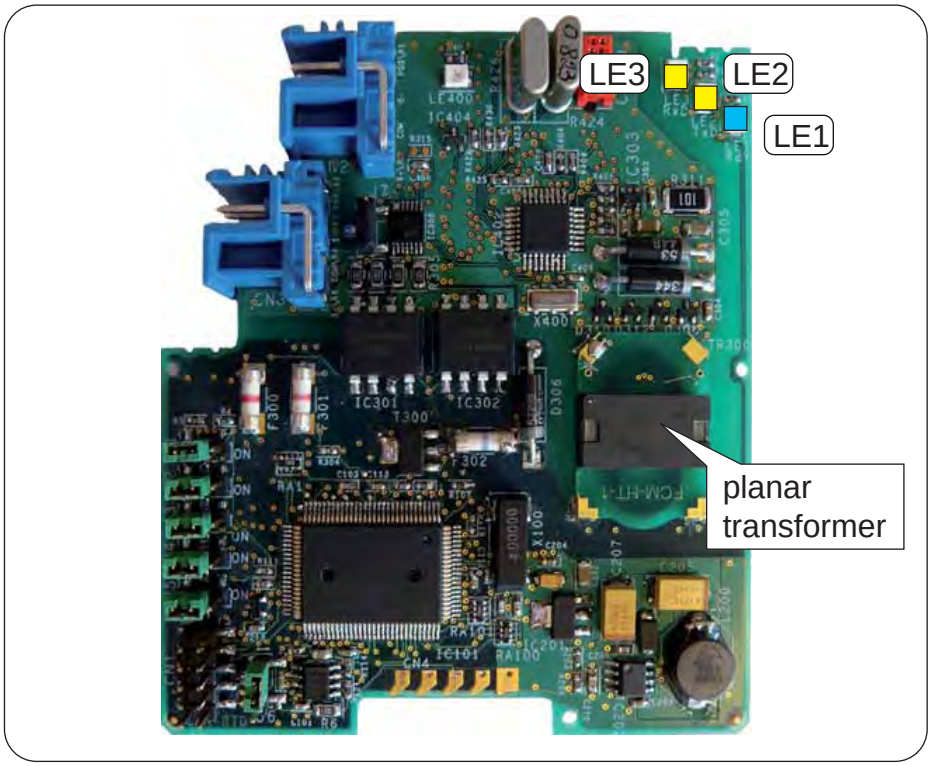


FIGURE 6-40 The FII-RTD board

ESF09-0008

There are 4 possible configurations:

- 1 or 2 RTDs in a 3-wire configuration
- 1 or 2 RTDs in 4-wire configuration
- 2 till 6 RTDs as a probe, called MPT, and which has 1 wire per RTD + 2 common wires for all RTDs
- 2 till 6 MRTs as a probe, and which has 1 wire per MRT + 2 common wires for all MRTs

NOTE: Only in RTD 3- or 4-wire configurations ambient temperature calculation is possible.

6.11.2 Some Important Settings

The FII-RTD can be tailored to the need of the customer by a lot of settings. See 6.11.4 - Commissioning.

Some important settings of the FII-RTD are listed below.

Setting	Remarks
[Element type]	Can consist of following types: • Pt100 large + small • Ni191 • PtCu100 • Cu100 • Cu90 Enraf + Beacon + Weston/Solartron/Nulectrohms • Sangamo MRT • Sangamo spot
[Measurement type]	Can be: • RTD 3-wire • RTD 4-wire • MPT • MRT
[RTD configuration]	Can be: • RTD1 in tank • RTD1 + RTD2 in tank • RTD1 in tank + RTD2 ambient • RTD1 ambient
[Gauge temperature scale]	Can be: • IPTS-68 • ITS-90
[Lowest element offset]	This is the distance from tank bottom till lowest element position
[Number of elements]	Can be 1..6
[MPT sensor length]	-

6.11.3 Some Important Features

- Temperature calculations can be:
  - *Standard* (just simple averaging the spot temperatures).
  - *Enhanced* (averaging the spot temperatures and taking into account the contribution of each spot in respect to its immersion).
  - *Custom* (as *standard* but then giving it a weighing factor).
- A *temperature-range check* can be turned on. In this case, if spot elements are out of range, a fail state results (if not skipped), see FIGURE 6-41.

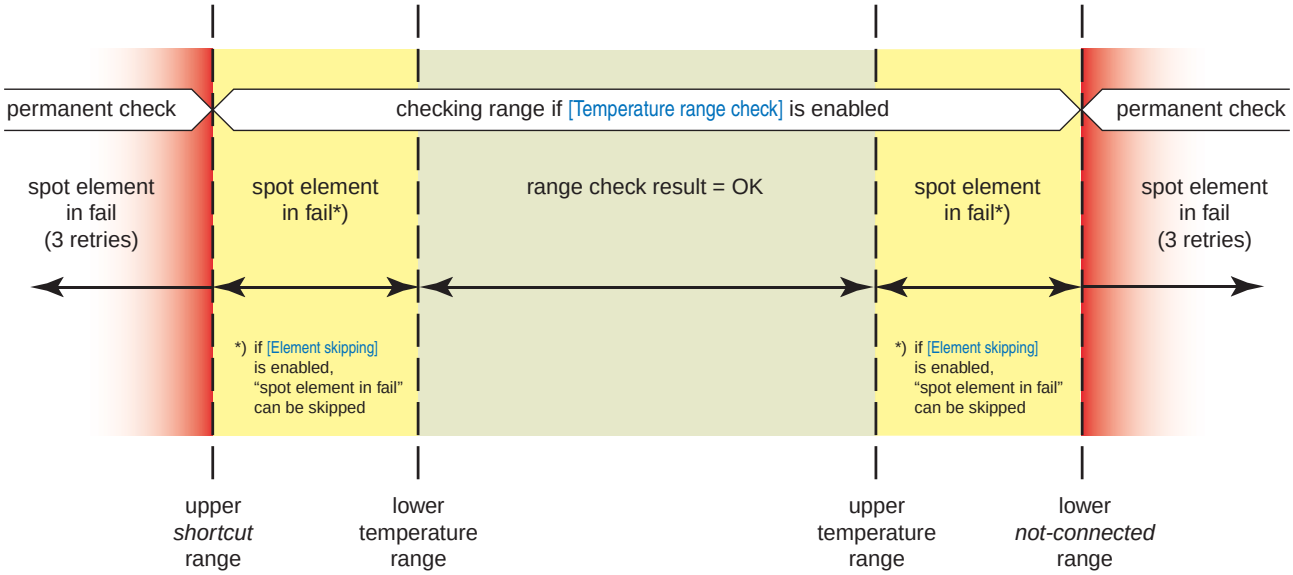
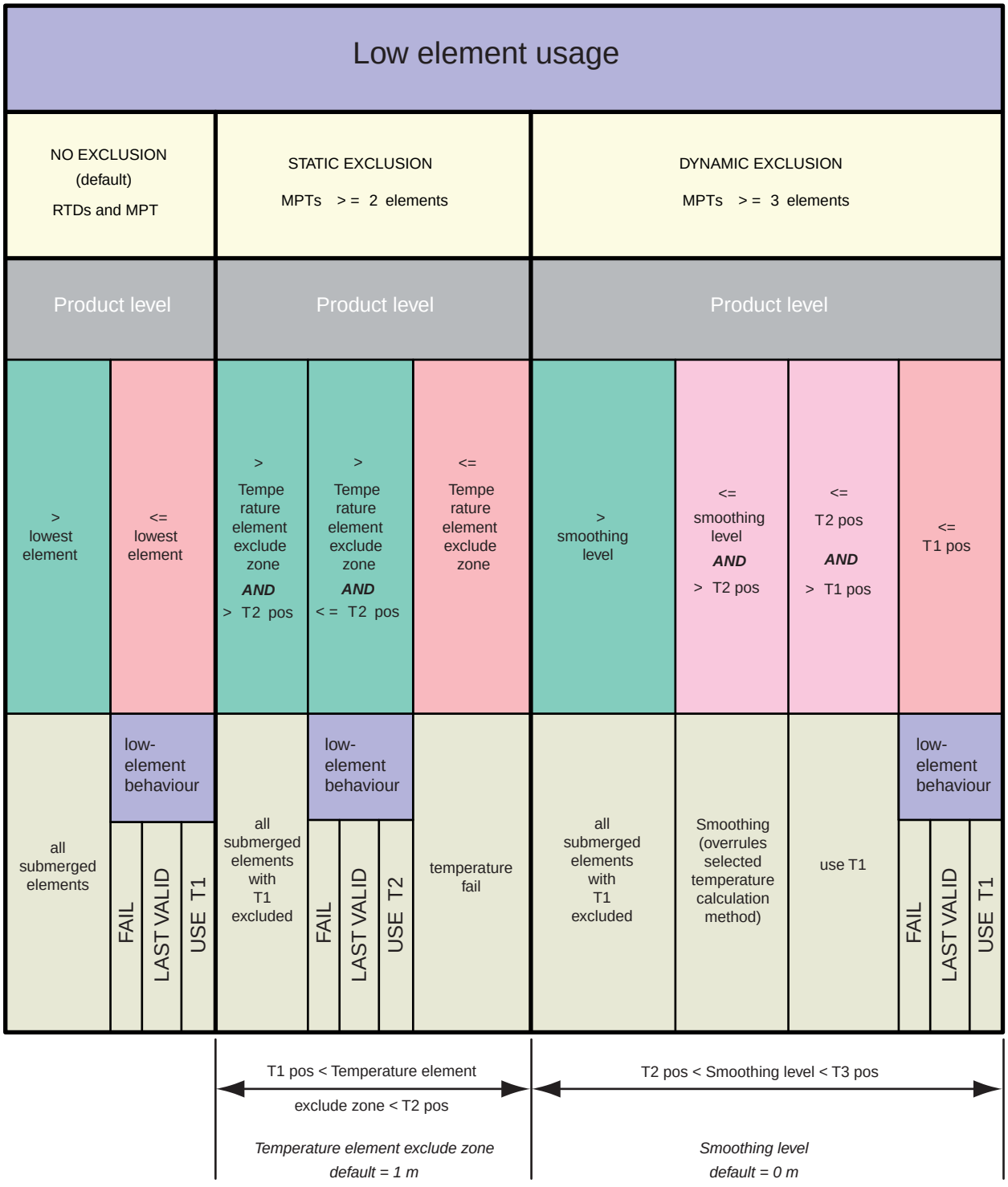

permanent check
checking range if [Temperature range check] is enabled
permanent check
spot element in fail (3 retries)
spot element in fail*)
range check result = OK
spot element in fail*)
spot element in fail (3 retries)
*) if [Element skipping] is enabled, "spot element in fail" can be skipped
*) if [Element skipping] is enabled, "spot element in fail" can be skipped
upper shortcut range
lower temperature range
upper temperature range
lower not-connected range

FIGURE 6-41 Temperature range check feature ESF09-0006

- A *median filter* can be turn on or off, which eliminates spikes of each individual calculated spot tempearture.
- An *averaging constant filter* can be turned on or off, which takes a certain part of the previous calculated average temperature and a certain part of the new calculated temperature into account.
- *Low element usage* with following possible sub-settings can be applied:
  - No exclusion
  - Static exclusion
  - Dynamic exclusion
    These settings are then to be refined further with:
  - Exclude zone
  - Smoothing level
  - Low element behaviour

See FIGURE 6-42 on next page.



ESF09-0007

FIGURE 6-42 Low element usage settings overview

- *W&M Sealing*[1]: This board can be electronically sealed via the software. A Notified Body can set his password via [W&M notified body seal password]. He can apply the seal by setting [W&M seal]. Here some data logging is filled in and the related password. This requires a W&M module for Engauge.
  If the primary value of the product temperature is completely valid, then a W&M indication will be set (e.g. visible in SmartView).

  Unsealing: give the [W&M unseal level 1] and [W&M unseal the level 2] commands successively.

  History can be made visible via [W&M seal history].

6.11.4 Commissioning

6.11.4.1 Commissioning Parameters for 1 or 2 RTDs (3- and 4-wire) Temperature Calculations

NOTE: Make sure the RTD/MPT jumper is set to RTD.

☛The following entities ***must*** be set set by *Engauge* or *SmartView* for a correct functioning of the FII-RTD module in an instrument. The default values are available after initialization of the non-volatile memory.

Name	Explanation	Value Range	Default
[Lowest element offset]	The distance from tank zero till the first RTD	floating point number: <-x.x .. +x.x>	<80.0>
[Second element offset] if applicable	The distance from tank zero till the second RTD	floating point number: <-x.x .. +x.x>	<0.0>
[Number of elements]	The number of RTDs used	<1..2>	<0>
[Element type]	The type (material) of the used RTDs	<Pt100 large + small> <Ni191> <PtCu100> <Cu100> <Cu90 enraf + beacon + weston/ solartron/nulectrohms> <Sangamo MRT> <Sangamo spot>	<No type>
[Measurement type]	Selects **RTD**s, MPT, or MRT.	<RTD 3wire> <RTD 4wire> <MPT> <MRT>	<No type>

1. Weights & Measures Sealing.

Name	Explanation	Value Range	Default
[RTD configuration]	Selects how the RTDs are positioned.	<RTD1 in tank> <RTD1 and RTD2 in tank> <RTD1 in tank and RTD2 ambient> <RTD1 ambient>	<No configuration>

6.11.4.2 Commissioning Parameters for MPT Temperature Calculations

NOTE: Make sure the RTD/MPT jumper is set to MPT.

☛ The following entities ***must*** be set set by *Engauge* or *SmartView* for a correct functioning of the FII-RTD module in an instrument. The default values are available after initialization of the non-volatile memory.

Name	Explanation	Value Range	Default
[Lowest element offset]	The distance from tank zero till the bottom of the probe	floating point number: <-x.x .. +x.x>	<80.0>
[Number of elements]	The number of elements used	<1..6>	<0>
[Element type]	The type (material) of the used RTDs	<Pt100 large + small> <Ni191> <PtCu100> <Cu100> <Cu90 enraf + beacon + weston/ solartron/nulectrohms> <Sangamo MRT> <Sangamo spot>	<No type>
[Measurement type]	Selects RTDs, **MPT**, or MRT.	<RTD 3wire> <RTD 4wire> <MPT> <MRT>	<No type>
[MPT sensor length]	The length of the MPT probe	floating point number: <-x.x .. +x.x>	<80.0>

6.11.4.3 Commissioning Parameters for MRT Temperature Calculations

NOTE: Make sure the RTD/MPT jumper is set to MRT (= MPT position).

☛ The following entities ***must*** be set set by *Engauge* or *SmartView* for a correct functioning of the FII-RTD module in an instrument. The default values are available after initialization of the non-volatile memory.

Name	Explanation	Value Range	Default
[Lowest element offset]	The distance from tank zero till the bottom of the probe	floating point number: <-x.x .. +x.x>	<80.0>
[Number of elements]	The number of elements used	<1..6>	<0>
[Element type]	The type (material) of the used RTDs	<Pt100 large + small> <Ni191> <PtCu100> <Cu100> <Cu90 enraf + beacon + weston/ solartron/nulectrohms> <Sangamo MRT> <Sangamo spot>	<No type>
[Measurement type]	Selects RTDs, MPT, or **MRT**.	<RTD 3wire> <RTD 4wire> <MPT> <MRT>	<No type>

6.11.4.4 Commissioning Parameters for All Types of Probes

*6.11.4.4.1 Engauge *Product temperature* Tab*

☛The following entities ***can*** be set set by *Engauge* or *SmartView* for a specific functioning of the FII-RTD module in an instrument. The default values are available after initialization of the non-volatile memory; so check each entity for its correctness.

Name	Explanation	Value Range	Default
[Product immersion depth]	The minimum required product level distance above an element before this element is taken into account in the average product temperature calculation	floating point number: <-x.x .. +x.x>	<0.5>
[Hysteresis]	This is a hysteresis mechanism distance around the switching points of the elements that are taken into account in the calculation.	floating point number: <-x.x .. +x.x>	<0.1>

Name	Explanation	Value Range	Default
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	4 thresholds for activating a related alarm status in the Primary Value	floating point numbers: <-x.x .. +x.x>	<1.0E22>
[Alarm test enable]	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is slightly below or above the alarm threshold.	<enable> <disable>	<disable>
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	<No Alarm> <High High alarm> <High Alarm> <Low Alarm> <Low Low alarm>	<No Alarm>
[Function identification]	The current module's function name. This function is visible on the *SmartView* display.	13 characters	<Product temp.>
[Element offset]	Each element can individually be given an offset.	floating point numbers: <-x.x .. +x.x>	<0.0>
[Element weighing factor]	Each element can individually be given a weighing factor, which is applicable if the calculation method is CUSTOM.	floating point numbers: <-x.x .. +x.x>	<1.0>
[Gauge temperature scale]	Determines whether the IPTS-68 or ITS-90 scale is used.	<IPTS-68> <ITS-90>	<ITS-90>
[Low element usage]	See FIGURE 6-42	<No Exclusion> <Static Exclusion> <Dynamic Exclusion>	<No Exclusion>
[Low element behaviour]	See FIGURE 6-42	<Temp To Fail> <Temp To Last Valid> <Temp Use First Element> <Temp Use Second Element>	<Temp To Fail>
[Temperature element exclude zone]	See FIGURE 6-42	floating point number: <-x.x .. +x.x>	<1.0>

Name	Explanation	Value Range	Default
[Smoothing level]	See FIGURE 6-42	floating point numbers: <-x.x .. +x.x>	<0.0>
[MPT element position mode] *[Only for MPT]*	Determines whether the element positions are automatically calculated (based on sensor length) or manually entered.	<Automatically> <Manually>	<Automatically>
[RTD element positions] *[Only for MPT]*	If MPT element position mode is MANUALLY then here the positions can be filled in.	floating point numbers: <-x.x .. +x.x>	<0.0>
[Averaging constant filter]	Enables or disables a averaging constant filter.	<enable> <disable>	<enable>
[Averaging constant]	Value of how much of the old calculated value is used with respect to the new calculated value	<0.0 .. 1.0>	<0.9>
[Temperature range check]	Enables or disables the fact that an element which is outside a temperature range will lead to temperature fail. (See also FIGURE 6-41.)	<enable> <disable>	<disable>
[Element skipping]	Enables or disables the fact that elements can be skipped if an element is outside a temperature range.	<enable> <disable>	<disable>
[Maximum skipped elements]	The number of elements that can be skipped	<1,2>	<1>
[Median filter]	Enables or disables a median filter of 5 levels deep (spike filtering).	<enable> <disable>	<enable>
[Temperature calculation method]	The way the average temperature is calculated (see also features above)	<Standard> <Custom> <Enhanced>	<Enhanced>

Name	Explanation	Value Range	Default
[MRT length table] *[Only for MRT]* 	Specifies whether a fixed range of MRT resistors is used (= <F>) or user configured lenghts (= <T>). Fixed lengths are: 0.65, 1.25, 1.95, 2.85, 4.15, 5.65	1 character <F> <T>	<F>
[MRT element length used if MRT length table is 'T'] *[Only for MRT]* 	The lengths of the MRTs including anchor eye	floating point numbers: <-x.x .. +x.x>	<0.0>

*6.11.4.4.2 Engauge * Vapour temperature * Tab*

NOTE: Some settings for vapour temperature calculations are shared via the product temperature settings.

☛The following entities ***can*** be set by *Engauge* or *SmartView* for a specific functioning of the FII-RTD module in an instrument. The default values are available after initialization of the non volatile memory; so check each entity for its correctness.

Name	Explanation	Value Range	Default
[Gas immersion depth]	The minimum required distance below an element before it is taken into account in the average vapour temperature calculation	floating point number: <-x.x .. +x.x>	<0.5>
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm] 	4 Thresholds for activating a related alarm status in the Primary Value	floating point numbers: <-x.x .. +x.x>	<+1.0E22>
[Alarm test enable] 	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>

Name	Explanation	Value Range	Default
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Function identification]	The name of the current function of this module. This name is visible on the SmartView.	13 characters	<Vapour temp.>

*6.11.4.4.3 Engauge * Ambient temperature * Tab*

NOTE: Some settings for ambient temperature calculations are shared via the product temperature settings.

☛The following entities ***can*** be set by *Engauge* or *SmartView* for a specific functioning of the FII-RTD module in an instrument. The default values are available after initialization of the non volatile memory; so check each entity for its correctness.

Name	Explanation	Value Range	Default
[High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	4 Thresholds for activating a related alarm status in the Primary Value	floating point numbers: <-x.x .. +x.x>	<+1.0E22>
[Alarm test enable]	Enables (*if* activated, see next listed entity) the simulation of one of the 4 alarms for a minute, by simulating the actual measured Primary Value is below or above the alarm threshold.	<enable> <disable>	<disable>
[Alarm test]	Activates and selects at the same time the Alarm test (if enabled with the [Alarm test enable] listed before, and the 4 alarm thresholds are properly set).	[No Alarm] [High High alarm] [High Alarm] [Low Alarm] [Low Low alarm]	<No Alarm>
[Function identification]	The name of the current function of this module. This name is visible on the SmartView.	13 characters	<Ambient temp.>

6.11.5 Commissioning Check

☛After having checked/set all before listed entities, make sure

- the [Board Commissioned], the [Product temperature Commissioned], the [Vapour temperature Commissioned], and the [Ambient Temperature Commissioned] entities are <True>;
- the [Board Health], the [Product temperature Health], the [Vapour temperature Health], and the [Ambient Temperature Health] entities are <GOOD>.

For viewing the *software version,* the Engauge *Generic tab* can be viewed; also a *Reset board command* can be issued here.

NOTE: In the SmartView situation, the Commissioning flag must be 'G' and the Health flag must be 'Y'.

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